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NOTES AND COMMENTS.

Foundrymen and the Competition.

There still seems to be considerable doubt in the minds of large numbers of foundrymen as to the scope of the competition.

We can well understand the position of the man in the small foundry being unable to deal with the whole of the requirements of the modern foundry. For instance, one of our readers, writing under the *nom de plume* of "Cooldreen," states he considered himself in an excellent position to deal with the foundry proper, but the subject of the arrangement and requirements of the other departments present almost insuperable difficulties for him. We would suggest that he collaborates with a second person in order to ascertain that such departments could be added without being detrimental to his general scheme.

Another correspondent, signing himself "Student," desires to know "why we insist on dimensioned sketches." The reasons are many, but the outstanding one is the basic reason for the existence of all mechanical drawings, *i.e.*, brevity. Another reason, second only in importance to the first, is the elimination of misinterpretations. Further, we are of opinion that the inclusion of sketches simplifies the question and is as much for the benefit of the competitor as the judge.

A Cheap Alloy.

It has been stated that "Steel is a far greater and cheaper controller of cast iron than any metalloid or ferro-alloy." When the fact that an addition of 15 per cent. of steel improves the tensile strength of grey cast iron by a minimum of 18 per cent. is taken into consideration this assertion is justified. At the moment good machinery scrap is about 70 per cent. dearer than steel turnings. A consideration of the above figures should help foundrymen to decide whether the time is not opportune to closely examine their products and to ascertain whether they could not make better and cheaper castings from semi-steel. Incidentally, it may be observed that by the addition of the correct quantity of steel to cast iron the transverse test result can be increased more than tenfold.

Sulphur in Cast Iron.

This subject is very adequately dealt with in another part of the current issue, and any criticism of that matter can only take the form of an amplification. The author points out that the effect of sulphur is in no way proportional to the percentage figuring in the laboratory report. Assuming 0.05 per cent. is returned in one case and 0.15 per cent. in another, and taking it for granted that the sulphur exists in the cast iron in both cases as sulphide of manganese, then the percentage of this compound will be 0.12 per cent. in the former case and 0.42 in the latter. One might reasonably assume that where less than half of 1 per cent. of sulphide of manganese is returned, it should not materially influence the physical properties of the iron. Unfortunately, however, the manganese sulphide is not equally disseminated throughout the mass, but often appears in segregated patches. The normal action is for the manganese sulphide to envelope completely the crystals, consequent on its being the last constituent to freeze.

Manganese sulphide is mechanically weak, and since it is interposed between each crystal, it breaks down their cohesive force and forms an infinite number of cleavage planes, along which fracture can comparatively easily take place.

Whilst we are in perfect agreement with the author as to the remedy he sets out, it should be stated that something in the nature of a drastic annealing may possibly be used as a temporary measure to overcome the ill-effects of high sulphur in a manufactured sample. By drastic annealing we mean a prolonged (and necessarily an expensive) heat treatment. Usually, though not always, the manganese sulphide cell-walls can be made to "ball up." This at least does give the crystals a chance of coming in contact with each other at some points, and naturally increases their cohesive force.

THE FOUNDRYMEN'S COMPETITION.

FIFTY GUINEAS IN PRIZES FOR BEST DESIGN AND EQUIPMENT OF A FOUNDRY.

To mark the change over of the FOUNDRY TRADE JOURNAL from a Monthly to a Weekly publication, the Proprietors have pleasure in announcing that they are offering two Prizes of Thirty and Twenty Guineas respectively for an article dealing with the subject of the design and equipment of a Foundry (ferrous or non-ferrous), with special reference to the latest labour-saving devices and machines, internal transport and handling tackle.

Competitors, by submitting articles, signify that they adhere to the following rules:—

(1) Competitors must be in the employ of an established British foundry subscribing to the FOUNDRY TRADE JOURNAL, or himself a subscriber.

(2) Articles must be illustrated with dimensioned drawings and sketches.

(3) The copyright of all papers and designs accepted for publication will become the property of the Proprietors of the FOUNDRY TRADE JOURNAL.

All papers must reach this office by Thursday, March 3rd, 1921. The decision of the Editor will in all cases be final.

The Moulding of Turbine Parts.*

An addition is being made to the hydro-electric installations at Niagara Falls by the construction of six hydraulic turbines, each of 60,000 h.p. capacity.

The first two turbines of this installation have been designed and are being built by the Wellman-Seaver-Morgan Company, Cleveland. The casing for this first unit has been shipped, and the shop erection is now under way. Its inlet diameter is 10 ft. and outlet about 38 ft.

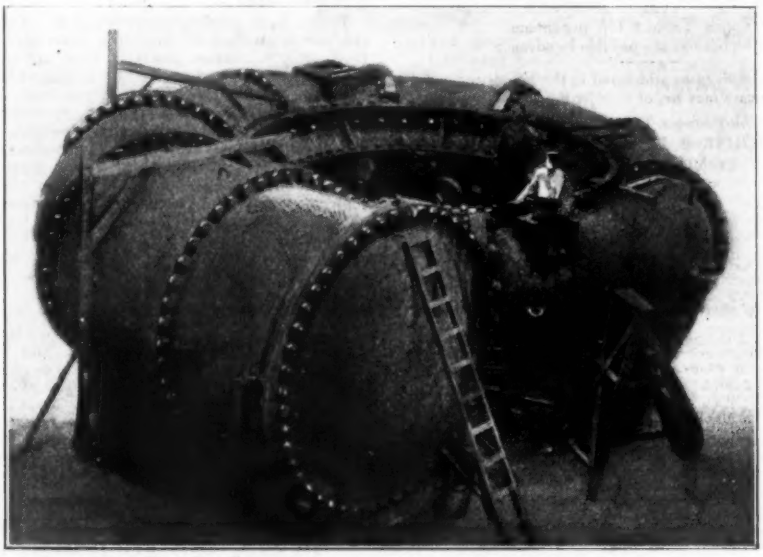


FIG. 1.—TURBINE CASING MADE IN NINE SECTIONS.

The casing, made in nine sections, is shown in Fig. 1. When bolted to the speed ring the casing was subjected to a shop test of 260 lbs. per sq. in. water pressure, or more than double the normal working pressure. Measurements taken during the test showed that all parts safely withstood this pressure without any excessive strains being set up in the castings or bolting.

The spiral casing weighs 98 tons, and the largest of its sections 16½ tons after the casting had been cleaned. In thickness the casing ranges from 2¼ to 2½ in. One section is a complete cylinder, the remaining sections having an opening on the inner side, in which the speed ring is fixed.

In order to secure castings that would safely withstand the required pressure-test, the various sections were cast on end, in order that all impurities would float into the risers, leaving the metal perfectly sound.

The core and pattern, and the flask set in place and rammed. The flasks were then removed and the surplus sand in the openings of the pattern struck off to conform to the size of the inside of the pattern. The core and flask, shown in Fig. 3, were dried out to insure a hard surface for the mould. The flasks were arranged with a parting at half the height of the mould to facilitate their removing and replacing. The castings obtained were uniform in thickness and exceptionally sound in every respect.

The mould was gated on two sides at the bottom, the gates being 3-in. in diameter, and the metal was poured from a 20-ton ladle. The largest sections had six 11-in. risers on the flange of the casting, these being sufficient in size and number to take all the impurities from the metal.

The casing was made from basic open-hearth steel running from 0.26 to 0.30 per cent. carbon. The test of the metal showed a maximum stress of from 31 tons to 37 tons per sq. in., and an elastic limit of from 17 to 23 tons per sq. in., the average being 33 tons tensile strength and 20 tons elastic limit. The average elongation was 27 per cent. and contraction 39 per cent. Two typical heats gave the following analysis:—

No. 1. carbon, 0.28 per cent.; silicon, 0.33 per cent.; sulphur, 0.026 per cent.; phosphorus, 0.028 per cent.; manganese, 0.44 per cent.

No. 2. carbon, 0.30 per cent.; silicon, 0.42 per cent.; sulphur, 0.02 per cent.; phosphorus, 0.02 per cent.; manganese, 0.49 per cent.

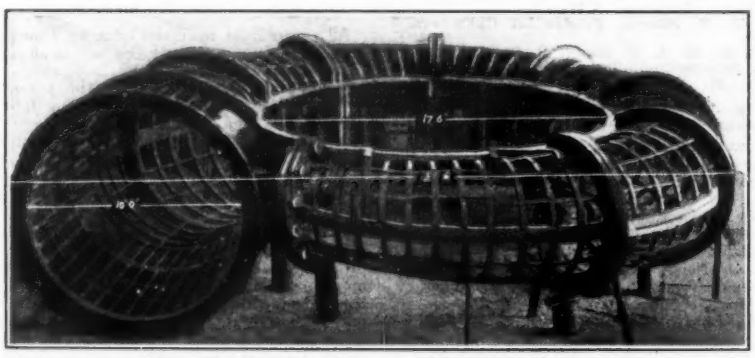


FIG. 2.—SKELETON PATTERN OF TURBINE CASING.

A skeleton pattern for the entire casing was first built and after completion was separated into the requisite nine sections. The moulds were made in green sand with a green sand core, secured in place by rods. Special 4-part cast-steel flasks, consisting of the cope, drag and two middle parts, were used, some of the flasks being 13 ft. 6 in. inside diameter.

In making the mould, the skeleton pattern, shown in Fig. 2, was provided with temporary sheeting fastened to the outside to hold in the sand. The core was rammed and the thin sheeting removed and the sand smoothed down to conform to the outside of the skeleton pattern. Paper was then placed round the

To facilitate the machining of the individual sections of the casing at the radial joints, six of the sections were designed to subtend an angle of 36 deg., and when the individual castings were assembled it was found that the castings were so true to pattern that they came to within ¼ to 1-16-in. of matching up on the inside at the joints. When the first section was machined it was found that there was some deflection of the sides of the circular casing due to its own weight because of the opening provided for the speed ring. Consequently ties were cast in the other casings, these ties being cut off after machining.

One of the runners for these turbines is shown in Fig. 4. It is made of steel cast in one piece, 10 ft. 5 in. in diameter, and weighs 14 tons. Extreme care was

* Extracted from a recent article in the "Iron Age."

taken in setting the cores for this casting, as the water passages and vanes must be uniform, smooth and true to design in order to secure high efficiency and to preclude corrosion. These runners when completed are accurately balanced, and great care was required in truing up the runner and shaft to insure perfect operation.

The main shaft at the coupling end is 30 in. in diameter, and through the bearing it is 31 in. in diameter. It is hollow bored to 8-in. diameter throughout its length of 22 ft. 3 in., in order to pass a cable

FIG. 3.—THE CORE AND FLASK.

through for handling the runner and removable draft tube when dismantling by use of the crane in the generator room. The flange of the main shaft is 53 in. in diameter at the generator coupling and 51 in. in diameter at the turbine coupling, and it was necessary for the Midvale Steel & Ordnance Company, which furnished the shafts, to forge them from 63-in. octagon ingots weighing 54 tons. The finished shafts weigh 24 tons.

The gates are steel, with the stems cast integral, and are machined all over to insure a proper guide to the water with a minimum of friction. The cast-steel levers on the ends of the gate stems are connected to the cast-steel operating ring by cast-iron links. These

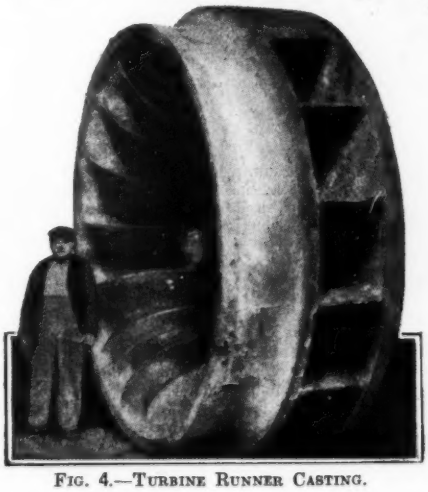


FIG. 4.—TURBINE RUNNER CASTING.

links are designed to break before the elastic limit of any of the other parts of the gate mechanism is reached.

Two 24- by 15-in. governor cylinders, bronze lined to prevent rusting, are used to operate the gates of each machine. They are connected to the operating ring by piston rods 6¼ in. in diameter. The operating fluid for the governor pressure system will be a mixture of water and a small amount of oil.

Every hydraulic feature was carefully studied to develop the highest attainable efficiency. In the mechanical design the aim was to obtain strength, ruggedness and simplicity throughout to insure satisfactory and continuous operation. Completely erecting the turbine in the shop will preclude any unnecessary fitting or machine work in the field.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

To the Editor of the FOUNDRY TRADE JOURNAL.

GENERAL CORE-MAKING.

SIR,—I do not, as a rule, reply to letters written under a *nom de plume*, but there are certain remarks of "Old Bill's" in your issue of January 20 which I cannot allow to go unchallenged.

The Coventry foundrymen are not ignorant of the advantages of sea-sand cores, nor are they ignorant of the disadvantages. Among the latter, the most important, to my mind, are the increased cost of sea-sand cores compared with ordinary sand, and the rougher skin imparted to the castings by sea sand.

I do not agree that the foundries of this country are far behind those in America, and, for general appearance and "finish," American castings are not, in the same street as those made in the Midlands.

The quality of the castings made in Coventry should be sufficient answer to "Old Bill's" charge of inexperience.

As to prejudice, the writer can only speak for himself. At the works at which I am engaged every facility has been offered to makers of patent binders, and my firm have spent many hundreds of pounds in trials. Expert representatives have come to the works and been encouraged to give demonstrations. If "Old Bill" would care to throw a light on our ignorance we are still open to be convinced.

Regarding the last paragraph, "that intricate cores for motor cylinders are made without rods or vents, from sea-sand and patent binder, which will stand up in the green state without packing," I have been familiar with this legend for many years, but have always understood that these cores were produced in the equally legendary foundry that never made a waster.—Yours, etc.,

F. H. HURREN,
President, Coventry and District Branch of the Institution of British Foundrymen.

January 21, 1921.

To the Editor of the FOUNDRY TRADE JOURNAL.

The CASTINGS TROUBLE.

SIR,—My article on "The Castings Trouble," which appeared in the December issue of THE FOUNDRY TRADES JOURNAL, has undoubtedly hit one individual hard, judging by the letter of "Manager," which was published in last week's issue. I observe that, even in the first instance, he is enraged to think that a buyer should have the temerity to air his views in the columns of this journal, and the really nice things he has to say about buyers generally suggests that he does not regard founding as a business proposition, but rather as an intellectual occupation. How annoyed he must be when some obnoxious buyer suggests a little business by sending an inquiry or by placing an order—but how alarmed he would be if the obnoxious one refrained.

Seriously though, I expected something better, and if "Manager" represents the opinion of the industry generally, then there is small hope for it. I am confident, however, that this is not so, and I want the practical readers of this journal ("Manager" included) to believe that all buyers are not the avaricious species portrayed by "Manager," and that the article in question was inspired by a genuine regard for the industry with which I am not altogether unacquainted.

I am ready to accept "Manager's" statement that things were not as they should be, even prior to the moulders' strike, the fact that such a strike was necessary being sufficient proof of this. I am well aware that the shortage of skilled men constitutes a serious problem, but the fact that a strike was necessary to prove that a moulder *was* a skilled man (and that is what it amounted to) suggests that something was lacking, and that the foundry industry was somewhat behind the times. This shortage could have been overcome had the foundry managers sought to make the industry attractive to boys, and I would ask "Manager" if *he* has ever endeavoured to do this. The engineer has the same trouble, but he has obviated "universal skill" by specialising, but he is handicapped in his efforts because of the high price and the indifferent quality of the castings he receives, and it is in this connection that the buyer suffers.

"Manager" says that the buyer deserves no sympathy, because he has not treated the foundry fairly in the past. He says: "I danced to your tune, now you dance to mine," but he is a very optimistic individual if he imagines this state of affairs will continue for an indefinite period. He says that the foundries are full, and likely to remain so, but I am content to live in my "fictitious paradise," because, since the penning of my article, the casting question is somewhat easier, both in regard to price and delivery. This proves that all founders are not of the same opinion as "Manager."

Then there is Continental competition, which must not be despised. Orders for castings can now be booked at a comparatively low figure, and good deliveries are given. But as Englishmen, buyers generally would rather spend money in their own country, and will do so if they are not prevented. I had this in mind when penning the article, which was not written as a sermon, but rather as a friendly hint as to what may happen, for with due respect to "Manager," the buyer knows more of what is taking place outside than does the man inside the foundry.

"Manager" affirms that the prices now charged are not inflated, and that they are justified. But how are they justified? By increased wages? By higher quality? By improved service? In regard to the two latter, the contention cannot be proved. In regard to the former—what of that bitter strike and its results? Does this prove superlatively high wages? I have not forgotten coal and freights, but are we not all hit?

The "knock off" contention to me seems absurd, for if a casting is defective, it is dear at any price, and I cannot understand any buyer accepting at a reduced figure. What I *do* know is that a hidden blow-hole will cause the engineer a good deal of trouble and expense, for which he gets no recompense, for although he can return the casting, and get another in exchange, free, gratis, and for nothing, I have yet to find the foundry which is prepared to pay the expense incurred in machining.

"Manager's" query regarding newcomers can easily be answered, for it does not mean that the buyer must have treated a foundry badly because he cannot get adequate supplies, and is obliged to endeavour to supplement them elsewhere. Neither is a buyer tied to one foundry. I venture to predict that "Manager" would not stick to one cobbler for his boots if he could (or thought he could) get better service elsewhere.—Yours, etc.,

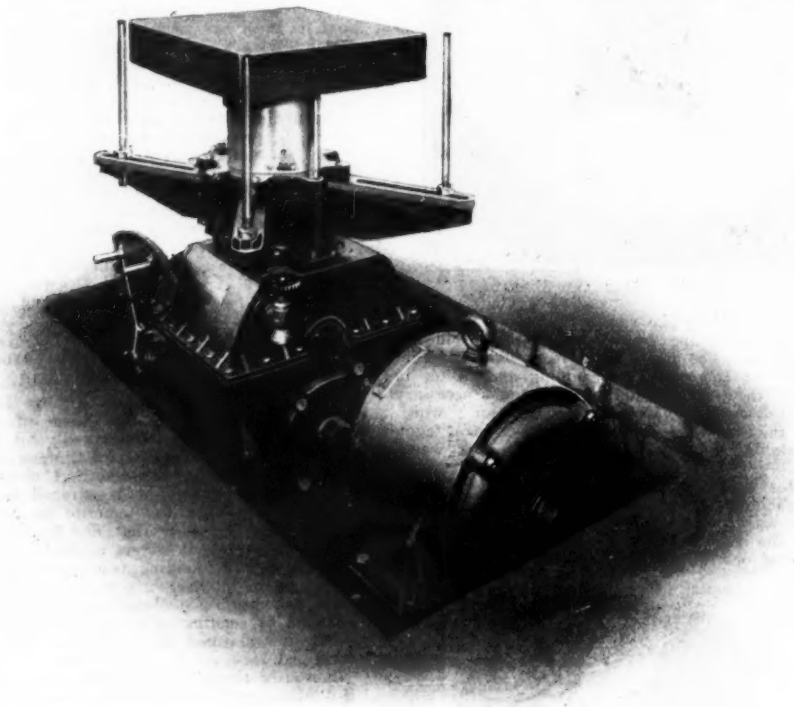
"A BUYER."

CUPOLA PRACTICE.—Mr. A. C. Porter, in a recent issue of the "Blast Furnace and Steel Plant," recommends the installation of a blast meter to eliminate any chance of error in calculation. The maximum temperature in cupola practice is attained by the formation and combustion of carbon dioxide gas, which requires one part of carbon and two parts of oxygen. This combination generates 68,040 calories at the melting zone. The oxygen is taken from the air delivered by the blower, the carbon is taken from the coke. This chemical reaction requires 150 cubic feet of air as delivered through the tuyeres and 1 lb. of carbon. Knowing the number of cubic feet of air delivered per hour, dividing by 150 gives the number of pounds of carbon required per hour to unite the air, to form CO_2 and the carbon content of the coke used, it is simple arithmetic to find the number of pounds of coke needed per hour to furnish the desired amount of carbon.

The "Pneulec" Moulding Machine.

The "Pneulec" moulding machine is designed to work under foundry conditions, is electrically operated, and, therefore, quite self-contained. In case of necessity the machine can simply be placed on a firm foundation, and connected up to the nearest electric supply main, every working part is protected, and the gearing runs in oil. The capacity is almost unlimited. It is possible to obtain, with suitable labour, anything between 40 and 200 moulds per day, depending, of course, on the size of the box used. The machine can be fitted with either 3 h.p., 4 h.p., or 5 h.p. motor; the 3 h.p. being capable of lifting and efficiently ramming a total weight on the table (pattern, sand and box) of 5 cwt.; the 4 h.p., 8 cwt.; and the 5 h.p. 10 to 12 cwt. Although, as a matter of fact, the machine has been tested up to nearly 15 cwt.

The jar of this moulding machine is very effective, as it is not solely dependent on the action of gravity, and does not rely on the weight of box and sand to give force to the jar. The action of gravity is greatly assisted by the piston descending in the cylinder, creating a partial vacuum which exerts a downward pull on the table of the machine. The advantage of this feature is obvious, and without it, a mould of light weight would take longer and more "bumps" to make it firm than a mould of greater weight. In the case of the "Pneulec" machine the size and weight of the mould is immaterial. The simplicity of the apparatus is one of its many advantages, only two levers being operated for the making of the mould, one lever controls the ramming of the mould, and the other withdrawal of the pattern.



A great feature of this machine is the means whereby the intensity of the jar can be easily altered to suit moulds of different types and varying weights. There are three methods of altering the intensity of the jar: (1) By means of a hand regulating valve; (2) by lifting plunger and table out, and screwing the plunger cap in or out as required; (3) by unscrewing the plunger sleeve itself to make the table lift higher, thereby giving a heavier fall.

Among the advantages claimed for the apparatus are: (1) The mould is rammed evenly and firmly, and hardness of mould can be regulated to a nicety, 60 bumps being usually sufficient for aluminium castings, 90 for deep iron castings, and 130 to 140 for steel castings; (2) machine-made castings require less dressing, and are more accurate in every respect, there being a total absence of strains due to uneven ramming; (3) largely increased output at a much reduced cost.

The actual cost consumption of electricity per hour for operating from test has proved to be only 1¼d. per hour, with current at about 2.4 pence per unit, using a moulding box 24 in. x 22 in. x 12½ in., and weighing complete with sand 4 cwt.

English and American Types of Electric Iron and Steel Furnaces Compared.

(*Continued from page* 55.)

By John B. C. Kershaw, F.I.C.

The Snyder Furnace.

The Snyder furnace is an American type of arc furnace, designed to reduce radiation losses to a minimum, and to give double the thermal efficiency of the older types of arc furnace. The following description of the furnace and its method of operation is drawn from a Paper contributed by the designer and patentee of the furnace to the 28th annual general meeting of the American Electrochemical Society, supplemented by more recently published notes and articles upon the furnace. The original furnace was of the one-electrode arc type, the current passing from this top electrode through the slag and molten metal to the bottom electrode embedded in the hearth. The furnace body was a circular shell lined with refractories in the usual manner; its distinctive feature was a removable cover which could be raised like the hinged lid of a box for charging purposes, and the joints of which were made gas-tight with sand, when the furnace was in operation.

FIG. 9.
VIEW OF A 5-TON SNYDER ELECTRIC FURNACE.

The water-cooled bottom electrode type of furnace has never been popular with practical electro-metallurgists, however, since it is most difficult to keep an electric furnace hearth in good condition when the refractory material is pierced by a metal electrode. It will be noticed that in the 5-ton modern type of Snyder furnace, shown in Fig 9, the furnace roof is pierced by two electrodes, and the bottom electrode has been dispensed with. In his original Paper the designer claimed that the one-electrode arc furnace, of 2½ tons capacity, was producing steel from cold scrap with a consumption of only 560 kw.-hrs. per ton of metal, and that the costs for labour and repairs were lower than with any other type of furnace. Figures were given showing that scrap could be melted and refined in this furnace, at the rate of ten tons per day of 11 hours, at a total cost of $19.00 or $21.00 per ton, *inclusive of the cost of the scrap-metal and alloys used*. These claims were criticised in the discussion that followed the reading of the Paper, upon the ground that no details had been given of the composition of the scrap used, or of the purification effected. There is no doubt, however, that a furnace constructed on the Snyder principle, with no charging doors, and with only two top electrodes of small sectional area, must lead to considerable savings in heat and electrode consumption, since air leakage into the furnace is almost entirely suppressed; but whether these economies are so large or financially important as the author claims may be doubted.

In an article published in the "Electrical Review" (Chicago) in 1917, Snyder stated that three-quarters of the total cost of electrodes was due to surface burning; the smaller the surface, therefore, the lower the cost. The size of the electrode, however, depended upon the current to be carried, and if the voltage between the electrode and the bath could be increased, the current could be reduced. This voltage was limited by the roof conditions, with the result that the limiting voltage between a single element and the bath was about 220 volts. If two or more electrodes were used through the same roof, the limit was about 110 volts between electrodes. For two electrodes this gave 55 volts between each electrode and the bath. With the same energy input to the furnace each of the two electrodes, therefore, must have double the cross-section of the single electrode with the higher voltage—that is to say, their combined cross-section was four times the cross-section of the single electrode. Their heat loss was therefore four times that of the

equivalent single electrode, and three times the sum of the heat losses of the single electrode and a contact to the bath. If three electrodes were used, the loss was still greater.

The cost of refractories arose chiefly from the roof, and the roof wear was substantially proportional to the number of electrodes. With a well-designed furnace, melting 1,000 tons of steel a month, this cost might be kept down to $4,000 per electrode per year. Since a single arc should be considerably longer than the arcs where two or more electrodes were used, it was cooler for the same energy; and if the electrode was cooler, there was less wear at the roof. Owing to the "constant" or fixed losses, the cost of electric energy for a given output could only be kept down if the input to the furnace was high rather than low. Thus the higher the input, the higher the heat efficiency. The only condition which limited the rate of input when once the charge has been melted was the rate at which the steel could be freed from oxygen. If air found its way into the furnace this rate was diminished; consequently the designer did away with doors and had a removable roof with a sand-joint. This arrangement also reduced the cost of labour. For these various items the designer summarised the savings per annum as follow:—

	Dollars.
Savings due to electrodes	11,500
,, ,, ,, refractories	8,000
,, ,, ,, electricity	7,000
,, ,, ,, labour	4,000
,, ,, ,, maintenance and capital charges	6,000
	36,500

This saving was equal to $45 per kw.-year.

The Snyder furnace is being employed by several steel companies in America for melting steel for castings, and for other purposes. Thus, the United Alloys Steel Corporation of Canton, Ohio, are reported to be using a 1½-ton Snyder single-phase furnace for melting 80 per cent. ferro-manganese, intended for addition to the steel in the open-hearth furnaces, and it is stated that by the use of special covering slags the loss of manganese is reduced, and considerable economy in the cost of the ferro-alloy is effected. Among other Snyder electric furnaces recently installed is one at the plant of the Frog Switch & Manufacturing Company, Carlisle, Pa., for the melting of a manganese-steel scrap which contains approximately 12.50 per cent manganese. The metal when poured from the electric furnace, after the addition of from 15 to 20 lbs. of 80 per cent. ferro-manganese per ton, shows a manganese content of from 12.25 to 12.50 per cent. Special slags are employed to reduce the loss of manganese.

The Vom Baur Furnace.

The Vom Baur furnace is a solid-bottom arc furnace designed for operation with polyphase current, and it resembles, therefore, in design and principle of its operation the Héroult type of furnace, and may be regarded as a modification of the latter. It is operated with two-phase current connected electrically on the three-wire system, and the three electrodes with which it is provided are arranged in a straight line. The following description is taken from Vom Baur's Paper read at the Birmingham (Alabama) meeting of the American Electrochemical Society in May, 1918. The furnace shell is oval; Fig. 10 shows a 6-ton furnace. The advantages of this shape of hearth, together with the 2-phase 3-wire connection, and the electrodes in a straight line, are many and far-reaching. When burning in a basic bottom, as the electrodes are in a straight line the heat of the arcs can be transmitted to a scrap carbon electrode lying horizontally on the bottom directly beneath all three vertical electrodes, and thence to the basic layer being sintered.

When the furnace is ready for operation, and cold metal is to be melted and treated, the charge thrown into the furnace piles itself into a heap, with its apex directly underneath the central electrode, which carries 41 per cent. more heat into the furnace than either of the two end electrodes; while underneath the latter there is a smaller amount of metal. This, then, is a natural condition for melting, and greatly facilitates the process.

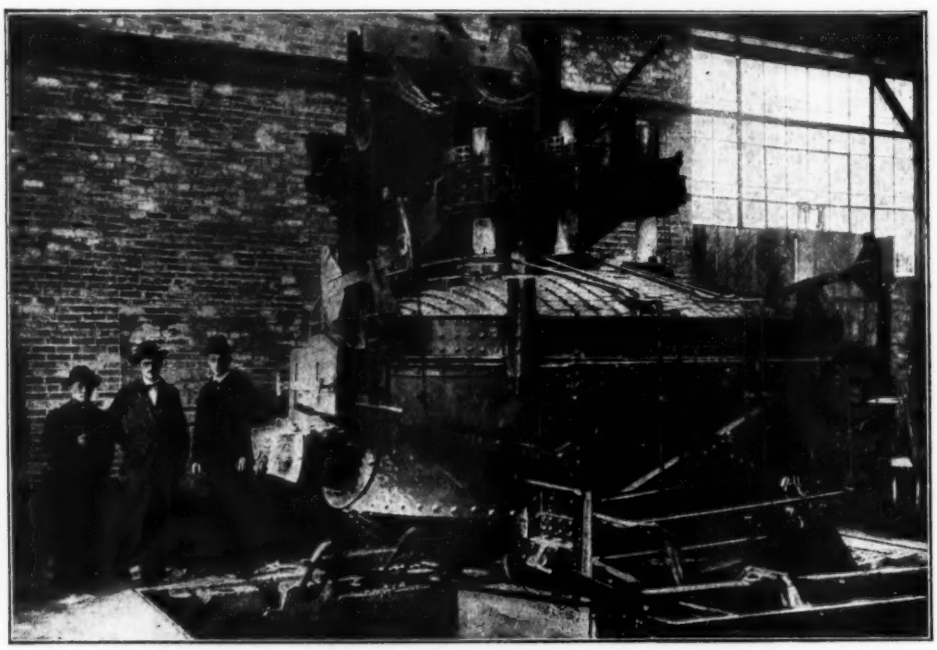


FIG. 10.
VIEW OF A 6-TON BAUR FURNACE.

When the furnace charge is once melted the excess heat is carried away through the walls and roof, when not too thick. If the walls are not subjected to a uniform temperature, they burn away at the hotter portions until they take on a curve exactly in harmony with the average excess heat which they have to endure. The Vom Baur furnace design, it is claimed, starting out with a theoretically and practically correct contour of side walls, does not suffer from these ills. Another advantage of this oval-shaped hearth is that, for a given capacity, the bath surface is larger and possesses a greater slag area. As the rate of steel-refining depends not only on the temperature at the point of contact between the hot-metal charge and the slag, but also on the amount of slag in contact with the metal, it is evident that this additional area of bath surface is of great advantage when refining. The circulation of the molten metal is also claimed to be ample, considering the greater heat directly beneath the centre electrode, as compared with that directly beneath either of the two side electrodes. (The designers and supporters of the conducting-hearth types of furnace would, of course, dispute this assertion.)

The electrodes can be regulated by automatic means or by hand. The phase voltage is usually 120 for melting-down, and may be 90 or even 60 for finishing, with reduced power. Voltage "taps" on the transformers are 120, 105 or 90; and the primary choke coils give an additional variation of 10, 20 or 30 volts from either of these points downward. Considering the experience gained recently with the Vom Baur furnaces for melting ferro-manganese and ferro-silicon, this furnace designs readily adapts itself to these purposes when fed with 1,500-kw. transformers.

In a later contribution to "Chem. and Metall. Engineering" Vom Baur adds that the doors of his furnace are provided with water-cooled frames which fit very tightly, and that the furnace structurally is very strongly built, being provided with a rounded and shaped bottom which sits on two rocker-arms, whereby the whole furnace can be tilted by suitable mechanism, either forwards for pouring, or backwards for removing slag. Either the front or the rear door may be used for charging. Graphite or carbon electrodes can be used with the furnace; those seen in Fig. 10 are of Acheson graphite, and either hand or automatic control can be furnished. The oval shape and turtle-back construction of the roof makes a very strong design, standard brick being used throughout for the roof construction, excepting for a few special electrode bricks. The electrical connections are the simplest possible, being merely three sets of cables from the transformers to the electrodes, with no complication on the high-tension side. Electrically the furnace conditions are satisfactory to the central-station managers, the power-factor being about 90 per cent. and the phases not being distorted more than with other arc furnaces. After continued operation it has been observed that the furnace does not bulge at all, this being another indication of the even heat distribution mentioned above.

The furnace is equally well adapted for melting down miscellaneous steel scrap; for castings on either acid- or basic-bottoms; for melting selected scrap for quality and tool steels; for melting down cast-iron borings; or for use with malleable iron. The furnace can be made in sizes from ¼ ton up to 30 tons capacity, and for any electrical conditions.

A Vom Baur furnace of 6 tons capacity has been operated at the Works of the Hercules Steel Casting Company at Milwaukee, Wisconsin, U.S.A.; and others are being installed both in America and Europe.

The Webb Furnace.

The Webb electric furnace, like the Vom Baur, is another American modification of the Héroult arc-type which has been designed for work with much higher voltages than are usually employed. The furnace shell is circular in shape, and is mounted as shown, on trunnions at the base for tipping purposes. The current is conveyed by three electrodes arranged in line, and is usually supplied from a three-phase supply at a maximum E.M.F. of 280 volts, although 440 volts have been employed successfully for a time with this furnace. A single arc is formed between the three electrodes and the bath, the arc stream acting as a multiple conductor with the material of the bath. The arc formed at this high E.M.F. is a long one, and no automatic control is required to regulate it. The E.M.F., however, is cut down towards the end of the time, when a lower heat is sufficient to complete the melting and refining of the metal. The original 3-ton Webb furnace melted and refined charges in from 3 to 4 hours when working with cold scrap, and in 2½ to 3 hours when charged with hot metal. The average electric power-consumption of the furnace is stated to be 600-650 kw.-hrs. per ton of charged metal, and over a three months' period the average electrode consumption was 5½ lbs. per ton. The roof requires repair once a month. Fig. 11 shows the 4-ton Webb furnace installed at the Works of the Old Dominion Iron and Steel Company for the production of steel ingots and castings. This furnace is equipped with Acheson graphite electrodes 6 in. in diameter.

Thermit Welding of Cast Iron.

In a recent issue of the "American Engineering and Mining Journal" some details are given as to the suitability of thermit for welding cast iron.

In thermit welding, the superheated steel produced by the reaction, when tapped into the mould surrounding the weld, fuses back into the fractured parts two or three inches on either side, and the whole mass, solidifying at one time, effects the repair.

Where steel is the welding medium in cast-iron welding it will necessarily consist of a mixture of this steel and the cast iron of the parts being welded, the graphitic carbon in the cast iron, combining with the thermit steel, to make a high-carbon steel, which usually can be machined only by grinding. This material, however, is not so brittle as cast iron and is physically stronger.

The weld material, being steel, has double the shrinkage of the cast iron. This difference in shrinkage is of no importance where the section welded is approximately square. Where, however, the length of the section at the fracture is four or five times its width, the difference in shrinkage is evidenced by one or more minute cracks perpendicular to the line of the weld and extending through the weld material only. Hair-line cracks will be found in the welding of sections, such as, for example, 12 in. × 2 in., but would not be found in sections 12 in. × 12 in. The cracks are unimportant as they are parallel to the line of strain. Extended experience indicates that thermit welds are successful where the length of the fractured section is not in excess of four times its width and where the subsequent machining can be done by grinding rather than by the usual processes.

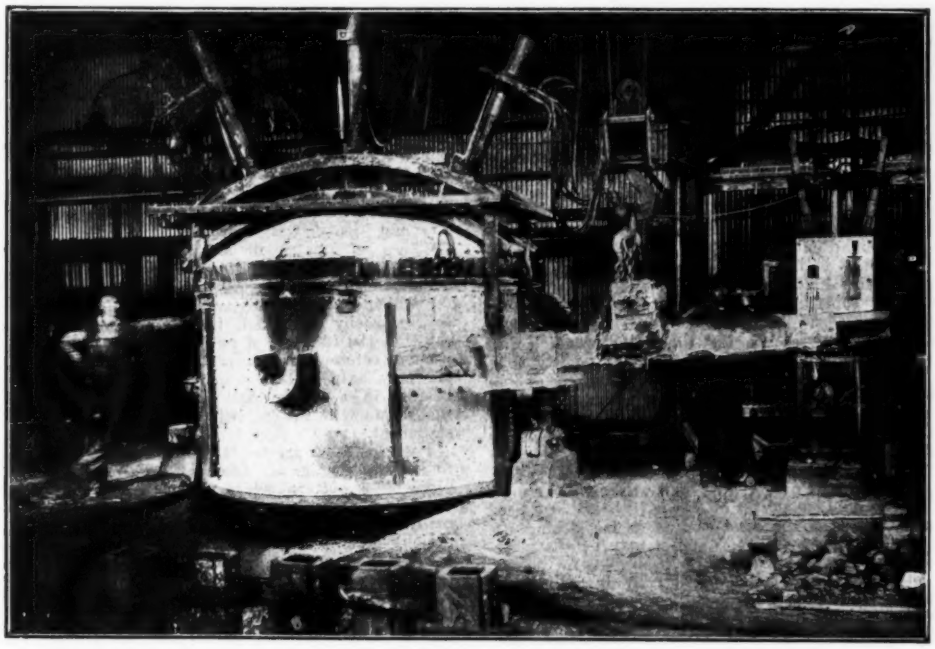


FIG. 11.
VIEW OF A 4-TON WEBB FURNACE.

CARE OF CRUCIBLES.—In a recent issue of the "Gas Age," Mr. Edward F. Davis emphasised the points with a view of increasing the life of crucibles. (1) Though crucibles may be adequately annealed by the manufacturer, they require re-heating on reception to 105 to 120 deg. C. to eliminate moisture picked up en route, as the sudden generation of steam may cause the pot to "spall." (2) Crucibles should afterwards always be kept dry and warm. (3) Crucibles should never be tightly packed on charging, as the expansion of the charge may crack the pots. (4) Continuous operation is always beneficial.

XUM

Is the Sand Casting a Necessity?

BY "A BUYER."

The sand-casting process has for long been regarded as an absolute necessity to practically every branch of the engineering industry, both on account of its low cost and also of its adaptability. As a consequence therefore it was much in evidence, and was so much depended upon, that the moulders' strike had a most serious effect upon the engineering industry as a whole. In the case of the sand casting the buyer was unable to get a substitute article, and so failure to obtain castings meant shortage of work in his factory and loss of employment to many of the operators.

Until the strike came, it is doubtful whether any buyer realised the importance of the casting, for adequate supplies were always forthcoming, with so little variation in the cast as to justify the standardisation of machining operations and rates. It was ever the first consideration of the draughtsman, for his first thought in connection with any new piece about to be designed was the possibility or otherwise of a casting. With the advent of the strike many firms had good reserves of castings, and it was not until the strike had been in progress for some time that the buyer began to realise what a shortage of castings would mean to his factory.

His efforts revealed his impotence, for he knew not where to turn. If he were fortunate, restricted supplies were available, but the almost perfect casting of a few months before had disappeared, and in its place appeared a miserable specimen which upset all the planned arrangements of the machine shop. And the question arose, "What can take the place of the casting?" A forging in one instance—a stamping in another—but these could not be utilised on a large scale, being either unsuitable or too expensive. The question of design had also to be taken into consideration. The maker of a certain commodity, which had been before the public for many years, and which as a consequence had acquired definite characteristics, dared not risk his reputation by changing the design in utilising substitute materials, and so the demand for castings was as insistent as ever.

Better the third-rate casting, the design of which was identified with the unit, than the higher quality substitute, even though the standardised machining operations were temporarily superseded, and the rates were increased three-fold. If the casting could be made presentable, either by patching or pegging, or any other handwork, then it was pressed into service, and the founders at last came to the conclusion that, so long as they produced castings, quality and workmanship were of small account.

The fact is that the sand casting is fast losing its claim to "indispensability," and it may be that, ere long, it will have to fight for its position. As before said, its chief claim to popularity lay in its adaptability and in its low cost, but these advantages seem to be rapidly disappearing. The first cost has gone up tremendously since the strike, whilst subsequent costs in the machinery and fitting shops have increased by leaps and bounds. The machine shop is at sixes and sevens—each batch of castings has to be rated on its merits, no set time being possible.

Machine shop planning is therefore in abeyance, and production is suffering accordingly. More labour is employed in the fitting department, and yet the output is less. Can it be wondered that the whole situation is under review, and that drastic steps are being contemplated to overcome the trouble? If the advantages which the sand casting offered are no longer in evidence, why retain this type of casting? It is obsolete, therefore let it die.

The railways monopolised transport, until they were thought to be indispensable. Necessity brought the motor lorry into service, and in a short time this will be recognised as a serious competitor. The die casting and the die pressing are not regarded seriously at the moment, nevertheless it is from this quarter that the attack upon the sand casting will be made.

It may be urged that these are expensive, despite the fact that machining processes are practically eliminated, but before the matter can be dismissed present-day circumstances must be considered. The high cost of the die casting compared with the pre-strike sand casting was no doubt pronounced, and, had the relative positions remained unchanged, it is possible that the question of competition would not arise. But to-day, with the cost of the die casting on the decline, and the cost of the sand casting materially increased, both in regard to first cost and also subsequent machining costs, etc., there is no doubt that the business man and the designer are looking somewhat farther ahead, and the sand casting is not regarded in the same light as formerly, as the acme of general utility.

We know that, so far as high fusing metals are concerned, die casting is not at the moment a practical proposition, but what the business man is asking is whether these high fusing metals are an absolute necessity. He has accepted cast-iron primarily because it was cheap, and although the ironmasters may argue that the general engineer is not likely to sacrifice his expensive plant and risk his reputation by a change in design, in order to utilise a different process, the ultimate value of which can only be conjectured, it is certain that thoughts *are* moving in that direction.

The movement will be gradual, but nevertheless sure. Already many of the smaller components are being die-cast, and sooner or later the larger parts will come up for review. If a man finds that practically the whole of his expensive machining operations can be eliminated, and he can get a much better finished article, he is going to consider very seriously the advisability of substituting an aluminium or other alloy for the cast-iron he has now to use.

It is a fact that to-day the buyer is prepared to listen to the wiles of the traveller concerned with die casting, and even though immediate business does not result these conversations are not without effect. There are few up to date engineering factories in which specimen die castings are not to be found, and these are the subject of much discussion.

Real business (*i.e.*, the desire to give satisfaction and thus increase business) is practically non-existent in the general foundry to-day. Let any buyer pay a surprise visit to one of the foundries with which he is doing business, and he will speedily see what is meant. Let him ask for one of his own patterns, and note the utter lack of systematic storage. There are exceptions, but they are few. In many general foundries there is no pattern store at all, and confusion is the obvious result. Where a customer insists upon the return of his pattern with the final consignment of castings, he can usually depend upon getting it, but should he not ask for the return of the pattern until some time has elapsed since the completion of the order, he will be lucky if he gets it, unless he pays a visit to the foundry and identifies the pattern.

There is too much trusting to memory in the foundry, and all moulders and managers are not "Pelmanists." In the case of a repetition line, orders for which are practically continuous, the pattern is, of course, easily identified, but otherwise it is safe to say that the identity of patterns cannot be established without reference to the customer's order. The manager may assume that a pattern for a pulley wheel belongs to a certain customer, but he must refer to that customer's orders before he can give a definite statement.

Patterns, too, are not treated so well as they used to be, and repairs are frequent. The moulder finds a piece on a pattern which presents some difficulty in moulding, and upon his own initiative (and without really appreciating what may be the result of his action) he prises the piece off, damaging other parts of the pattern in so doing, and using it as a loose piece. It would seem to the buyer that every pattern received from customers should be carefully studied before being put into commission, and the patternmaker's ideas correctly interpreted. Any point which cannot be satisfactorily explained should be referred to the customer, who could either forward the necessary particulars through the post, or, if warranted, would send his patternmaker to the foundry to make the necessary explanations, or to make what adjustments are considered desirable.

It is observed that the ideas of patternmakers vary considerably, and it is hard for a moulder to correctly interpret the wishes of the outside patternmaker. Where the foundry and the pattern shop work in conjunction in one factory this state of affairs is not so apparent, as the patternmaker is conversant with the peculiar moulding conditions, and makes his pattern accordingly. But with a little care and foresight many of the troubles in connection with customers' patterns could be obviated before the patterns are put into commission, this saving confusion and expense, to the benefit of the customer and also of the foundry.

FAILURES OF WELDED STRAIGHT PIPING.—An unsual contraction problem arose recently in connection with the pipe welding on fifty-four large gasoline condensers for the Texas Oil Company. Each condenser consists of four large forge-welded drums and seventy lengths of extra heavy 2-in. pipe. The drums are open at one end and flanged so that they may be bolted or riveted together after the pipes are welded in.

The original plan called for straight piping in line of centre between each lateral pair of drums and bent or bowed piping to connect the sides. As the distance between the drums had to be exact to meet the foundation specifications and to ensure coincidence of the flanges and bolt or rivet holes of one set of drums with the corresponding points in its mates, the importance of properly handling the contraction problem is at once apparent.

Moulding Engine Casings in Loam.

BY A. B. SMITH.

The writer has endeavoured in the following article to demonstrate the advantages gained by making engine casings by loam in preference to sand moulding.

The dimensions of the tackle used for the job, which is cast "in open sand," vary with the size and weight of the casings.

The cast-iron bottom plate, shown at A in FIG. 1, should be at least 2 in. thick, and should be provided with two holes centrally cast for the purpose of assisting contraction, alleviating warping, and venting the finished mould. There are four lugs for bolting and handling.

The frames, shown at B, Fig. 1, the number of which is determined by the height of the casing,

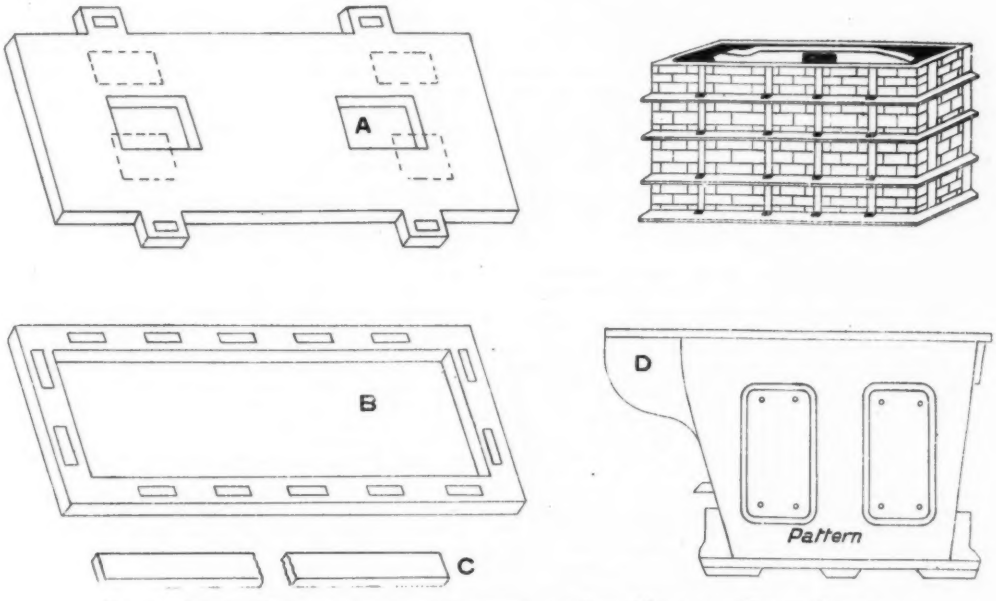


FIG. 1.—SHOWING DETAILS OF THE CONSTRUCTION OF A LOAM MOULD FOR ENGINE CASINGS.

should be about 1½ in. thick and slotted, to allow of the flat bars (C) to pass through easily. These bars have a section of about 4 in × 1 in., and are used for subsequent bracing.

The top plate is similar to the base, with the exception that the holes, shown dotted, are left for runners and risers.

The base plate is raised from the ground by means of a few bricks. A layer of fine ashes in the form of a ring is first laid on, after which a bed is formed with loam. The pattern is then placed in position and well bedded in with loam. It is now advisable to stiffen up the loam by incorporating some pieces of old core cake. The building up of the mould is carried out by laying tiers of old bricks and loaming in the joints; the outside of the brick wall must be kept inside the bracing bar slots. On every three or four courses a fresh frame is placed, care being taken to allow spaces opposite the "window" cores for the purpose of tying-in the cores. When nearing the top of the pattern it is best to have the last frame under the last course of bricks, thus making a good bearing for the top plate. The flat bars are now slipped in through the slots; they should just clear the top joint and touch the base plate. The bars are wedged tightly in the slots and the space between the outside of the wall and the inside of the bars should be loamed up. The whole is then left overnight to finally stiffen. In the morning the pattern is withdrawn, the mould rough finished and stoved.

After drying it is sand-papered, ready for the reception of the window cores. After their insertion the joints are filled in, and the job is finished off with a coat of blacking. It is unnecessary to re-stove, as one night's drying with a kettle will be sufficient.

The top plate having been struck in loam of about 1 in. in thickness by means of a strickle and dried, the runners and risers are cut, their positions having been determined by chalking.

When cored the top plate is once more placed in position, it is finally bolted down by means of the lugs on the sides of the plates provided for that purpose. The finished mould is indicated in the figure.

Book Reviews.

GOVERNMENT AND PEOPLE, by Conrad Gill, M.A., and C. W. Valentine, M.A., D.Phil. Methuen & Company, Limited, 36, Essex Street, London, W.C.2. (Price 7s. 6d. net.) The authors deal in an exhaustive manner with a subject affecting every citizen. All phases of British Government, from the Parish Council to Parliament, are included. The book will undoubtedly serve as an excellent text-book for the envisaged continuation schools.

MECHANICAL WORLD YEAR BOOK, 1921. Emmott & Company, Limited, 65, King Street, Manchester. (Price 2s. 6d.) The high standard of this popular reference book is fully maintained. Amongst other new features which appear are: Cast tooth gearing, ball and roller bearings, friction and lubrication. Many sections are distinctly useful for foundrymen.

Publications Received.

"The Autocar" (Iliffe & Sons, Limited), 20, Tudor Street, London, E.C.4.—A souvenir of the 25th anniversary of "The Autocar."

The Swansea Harbour Trust.—A booklet giving the tides, rates and dock facilities of the Port of Swansea.

Frederick C. Mathieson & Sons, 16, Copthall Avenue, E.C.2.—"Handbook for Investors, 1921." (Price 5s. net.)

The Inventors' Union, 316, Regent Street, London.—"Annual Review." (Price 1s.)

Messrs. Alfred Herbert, Ltd., Coventry: Illustrated Works Souvenir and Grinding Wheel Selection Charts.

ELECTRIC IRON FURNACE. — An electric iron-smelting plant is being built in Ribeiro Preto, Province of Sao Paulo, Brazil, by the Companhia Electrica Metallurgica Brazileira. The construction will start as soon as the American contractors get their engineers on the ground. The plant will be 75 miles from the mines of iron ore in the Province of Minas Geraes.

FUTURE OF AMERICAN ELECTRIC FURNACES.—At the December meeting of New England Foundrymen's Association Mr. F. J. Ryan, president American Metallurgical Corporation, Philadelphia, stated the time is comparatively near when those metal-melting industries depending on coal for heating purposes will not be able to compete with those operating electric furnaces unless there is a marked reduction in the cost of coal and much greater efficiency on the part of transportation companies. A recent investigation showed, he said, that the chances of industry having electric power delivered to it are 60 per cent. as against 40 per cent. in the case of coal. The solution of the transport problem lies in cutting down the tonnage of basic materials hauled.

XUM

Good and Bad Patterns.

By JAMES EDGAR.

In spite of what is often said to the contrary, patterns are as well made to-day as they were thirty years ago, and, from the moulders' point of view, probably better. With the growing intricacy of designs new methods of dealing with loose pieces have been adopted, as is instanced by the use of metal dowels instead of wooden ones.

There need be no conflict between art and utility as far as the patternmakers' craft is concerned. Some workmen think that every pattern should be equally well finished whether one casting or one hundred are wanted. There is no good reason, and never was, for putting a very fine finish on a one-off job. A rough pattern even if it entails a little more labour in the foundry, is an economy, and there are many occasions when price determines whether a pattern shall be made or not. There is plenty of scope within these limits for art in the patternshop. If the patternmaker guides and assists the moulder to make an accurate and beautiful casting he can take a legitimate pleasure in the casting in some degree as his work.

Some firms spend a considerable sum each year making castings which are immediately scrapped because a slight improvement is thought possible. The way in which the patternmaker—and moulder also—can assist here is by turning out a reasonably cheap casting. Otherwise they ultimately hamper what is hoped to be a distinct gain for the respective crafts.

The above applies peculiarly to internal combustion engine work, in which improvements are continually being made, but it is also good policy to deliver cheap work for plant repairs.

The quality of patterns should depend entirely on the purpose for which they are wanted, and the number of castings required. The man who has all his life been employed on fine work for quantity production need not look askance at a skeleton or other cheap pattern which may really be better for the occasion than a fine carved piece of work. On the other hand, it is sheer folly for firms to make shoddy patterns if they are to be used for years. A pattern that is well filleted, rounded and tapered, and afterwards painted and varnished, soon repays for its initial cost, and such work cannot be made in a hurry. The benefit is found in the foundry, when it literally jumps from the sand and practically no making-up is required. There is nothing more annoying in the foundry than a pattern that looks well but tears the sides of the mould either because of the absence of taper or because of the jointing of the timber. Even good craftsmen do not always remember that it is bad practice to cross timber that will be on the side of a mould, and very important to join timber with the annular rings back to back, so that the tendency of the one piece of timber to warp will be counter-balanced by the other.

DETERMINATION OF INSIDE DIAMETERS. — The United States Bureau of Standards has developed a new method for measuring the inside diameter of plain ring gauges by the use of two steel balls, the sum of whose diameters is slightly greater than the nominal inside diameter of the ring to be measured. The ring having been placed on a surface plate the larger ball is put in the ring; the smaller one then rests against the inside of the ring and on the larger ball. The difference in the height of the upper surfaces of the two balls is determined by means of a micrometer attachment. This dimension is converted into the vertical distance between the centres of the two balls. The value thus obtained forms one side of a right-angled triangle whose hypotenuse is the line joining the centres of the two balls and whose base it is desired to determine. The vertical side and the hypotenuse, having been found, it is possible to calculate the length of the base, which, added to the radii of the two balls, gives the inside diameter of the ring.

GRAIN SIZE IN CARBON STEELS. — According to recent research by the U.S. Bureau of Standards, the relation which exists between the size of grain and hardness in certain steel alloys does not exist for carbon steel, except in cases of very pronounced increase in grain size. Five types were studied under various conditions, and the varieties of grain-size were produced by annealing for long periods at different temperatures, as well as by low-temperature annealing after a preliminary straining of the metal. "In general," so the experts affirm, "there appears to be no definite relation between the grain-size and Brinell hardness. . . . The general effect of heating steel, or annealing it, is to harden it appreciably. This hardness is noticeable in spite of any sharp drop which may accompany an abrupt change of grain-size. The rate at which steels are cooled, and, consequently, the structural condition of the hardening constituent, affects the hardness much more than any other factor."

The Platinum Resources of the Empire.

The latest volume of the Monographs on the Mineral Resources of the Empire, which are being issued by the Imperial Institute, has just been published by Mr. John Murray. It deals with the platinum metals (platinum, iridium, palladium, osmium, etc.), and has been written by Mr. A. D. Lumb, A.R.S.M., F.G.S., of the Scientific and Technical Department of the Imperial Institute, under the direction of the Mineral Resources Committee of the Imperial Institute.

It is generally known that during recent years the demand for the platinum metals has been very great, due to the extension of their uses. Especially was this the case during the war with the chemical industries, which use platinum and palladium as catalyzers in the various "contact" processes for making acids and ammonia, and also largely in chemical and physical apparatus. Platinum is also used to a great extent in dentistry, in jewellery, and for certain parts of electrical instruments. The Urals of Russia were for long the chief source of platinum, yielding before the war about 90 per cent. of the world's production, Colombia coming next with about 7 per cent. The British Empire's output is about one-third of 1 per cent. Platinum occurs in many places in the world, as will be seen by a map included in the volume, but supplies from the few that are producing are nearly all small. The chief sources in the British Empire are Canada and Australia, the latter producing it as alluvial material, the former mainly as a by-product in the refining of copper and nickel mattes. In consequence of the collapse of the platinum industry in Russia, the search for the metal has been vigorously prosecuted in other countries. Colombia has greatly increased her output. The book gives in an introductory chapter information on the occurrences and properties, analyses, and metallurgical treatment of the platinum metals; their uses, their alloys and the various substitute alloys that are in use, and concludes with statistics of production of the world. A second chapter deals with all known occurrences of platinum within the British Empire, describing their geology and giving analyses of native metals, tables of output, and other statistical information. A third chapter gives similar information regarding foreign countries, a considerable proportion being devoted to Russia and America, especially the United States, Colombia, and Brazil. The volume is completed with a bibliography of recent literature on platinum.

ATTENTION is directed to the practice of testing low tension electric detonators by passing a small current of electricity through them in series with a galvanometer. Explosion of the detonator has resulted in some cases in injury to the operator. All danger can be eliminated by placing the detonator to be tested in a strong iron pipe or other suitable receptacle before passing the current through it.

TESTS OF THE ELECTRIC IRON PIPE.— The American Cast-iron Pipe Company, of Birmingham, Ala., have obtained the following tests of electric iron, extending over a period of months, and have demonstrated it to have a tensile strength running from 13 to 17 tons per sq. in., and a transverse strength in the standard 2-in. × 1-in. bar of 2,600 to 3,500 lbs., with a deflection of 0.38 to 0.50 of an in.

NICKEL-PLATING OF ALUMINIUM. — At the opening meeting of the French Society of Civil Engineers an interesting paper was presented by M. Léon Guillet, professor at the Conservatoire des Arts et Métiers, who discussed the problem of the nickel-plating of aluminium. This is not a new question, but all the patents dealing with this subject have not given satisfactory results.

The problem is that of developing the use of aluminium for coatings and obtaining a metal which is not attacked by different liquids, particularly sea water. Good results are not obtained with perfectly polished aluminium. Neither should there be a too pronounced scouring. M. Guillet has obtained excellent results by a cleaning with jets of sand under light pressure (600 g.), followed by a nickel-plating of 0.05 mm., then a copper-plating of 0.012 mm., and finally a second nickel-plating of 0.06 mm., the nickel-and-copper-plating being effected in baths by the ordinary procedure. Pieces thus prepared have been perfectly successful. Tests of stamping, of folding, and of burnishing, as well as the action of caustic soda, have proved the good quality of the nickel-plating obtained. The process has not been patented, and M. Guillet is quite ready to give further explanation to those interested. His sole interest is only to facilitate and popularise the use of aluminium.

Institution of British Foundrymen.

LANCASHIRE BRANCH.

At a meeting held at the Manchester College of Technology on December 4, Mr. W. H. Meadowcroft presiding, a lecture was given by Dr. F. J. Brislee, of Robey, Lancashire, upon Modern Metallurgical Investigation.

Modern Metallurgical Investigation.

Dr. Brislee said there was a very striking contrast between a modern text-book on metallurgy and any standard book on that subject published a decade ago, such as the classical work of Percy. If that monumental work was compared with the splendid Introduction to the "Study of Metallurgy," by Roberts-Austen, or Rosenhain's "Physical Metallurgy," it would be evident that there were few points of similarity between them, and that the whole subject had undergone a profound change. In the earlier works the problems mainly dealt with related to the extraction of metals from their ores, the purification of the metals, and methods of chemical analysis. Very few alloys were in use. To-day there existed a splendid literature on metallurgy containing many treatises on the extraction of metals, chemical analysis had progressed, and carefully worked out and tested methods for the accurate estimation of the various elements were available. In addition, there had been built up the new science of alloys and intermetallic compounds. The whole resources of science had been applied to the investigation of metals individually and in admixture or combination as alloys. On this occasion it would not be possible to do more than indicate a few of the more important points, and he would deal mainly with alloys of the non-ferrous group. Thanks to the Alloys Research Committee of the Institution of Mechanical Engineers, complete series of alloys had been investigated. In addition to that Committee, a large number of highly-trained and skilled workers had carried out researches on other alloys.

Before the alloys could be investigated the properties of the constituent metals must be determined and their suitability for a definite purpose decided. Two metals would form an infinite number of alloys, but it was only necessary to investigate comparatively few of the series. If some large change in properties occurred at any stage this portion would be examined more in detail, and alloys of intermediate composition investigated.

The research on a series of binary alloys (consisting of two metals) followed a fairly definite scheme of work, determining (1) the melting points of the two constituent metals; and (2) the melting points of mixtures of the two metals, the composition being accurately ascertained by analysis. From these data the melting point curve—the first step to the equilibrium diagram—could be drawn.

The micro-structure of the pure metals and the alloys in the cast, worked and heat-treated conditions, was determined and photographed. The changes in structure, and in properties also, which took place in the solid could then be followed. Changes in mechanical properties (such as tensile strength, resistance to impact, and hardness) were observed, and the micro-structure correlated with them. The equilibrium diagram could then be drawn, and furnished a most valuable guide to the subsequent use of the alloys. Investigation was also made of the electrical properties, corrosion density, and other physical characteristics. The complete investigation involved the consideration of the behaviour of the metals under varying conditions of temperature and stress, and revealing many anomalies, and often a reversal of well-known characteristics. For example, lead became sonorous like bell metal when at the temperature of liquid air, whereas at ordinary temperature it has no ring.

The two great discoveries which made it possible to progress forward in metallurgical science were the perfecting of means of accurately measuring high temperatures, and the use of the microscope and photo-micrography in the examination of metals and alloys. It was Josiah Wedgwood, the Staffordshire potter, who first attempted to measure high temperature. He realised that the production of high-class porcelain and pottery depended upon a proper firing temperature, and he introduced the pyrometer which bore his name, and which depended upon the contraction of a clay rod. For close upon a hundred years this remained the only instrument for measuring high temperatures. Another potter introduced cones made of different mixtures of clay, which fused at different temperatures. Modern instruments, known as pyrometers, were practically of three kinds: Thermo-electric, resistance, and radiation.

The thermo-electric pyrometer depended upon the current produced when the junctions of two dissimilar metals were at different temperatures. The current was measured by a millivoltmeter. When one junction was heated to the temperature to be measured, the other being maintained at a constant temperature, the number of millivolts indicated was proportional to the difference of temperature of the two junctions, and if one junction was kept at constant temperature the indications of the millivoltmeter could be converted directly into centigrade or Fahrenheit degrees.

A resistance pyrometer depended upon the change of resistance of a coil of fine wire, usually platinum or a platinum alloy, with change of temperature. For general use the thermo-electric type was simple and fairly robust, requiring only a galvanometer or millivoltmeter. The resistance type required a battery and a fairly complicated measuring device. Both were made into handy technical instruments which could be relied upon for hard foundry use.

Radiation pyrometers were of various types. The Fèry was a thermo-couple of bismuth and antimony, or other suitable pair of metals, upon which the radiations from the furnace or heated body were directed by means of lenses, and the current generated was measured on a millivoltmeter, which read directly in degrees. Closely allied to the radiation pyrometers were optical pyrometers. These types had a great advantage over the thermo-electric and resistance types, in that their working parts were not exposed to the destructive action of the high temperature in the furnace or to furnace gases. They were at some distance from the source of heat, and did not become heated more than a comparatively small number of degrees. They did not indicate with very great accuracy temperatures below a visible red heat (say, 500 deg. Cent.), but they were of the greatest service in determining casting temperatures, and very high temperatures in pottery kilns, glass furnaces, and smelting furnaces. Records of the temperature could be made at definite time intervals, and the recording instrument could be kept in an office away from the dust of the foundry or furnace room.

The second great discovery which enabled metallurgical science to progress was the application of the microscope and photo-micrography to its problems. It was due to Dr. Sorby, of Sheffield, that the microscope was first used to investigate the structure of metals, and it now formed part of the equipment of every modern engineering or metallurgical works. The specimens were cut from the ingot, sheet, rod or bar. If the metal was drawn, rolled or forged two specimens at right angles to each other must be prepared, *i.e.*, one parallel to the direction of work and one at right angles to it. It was then filed level, smoothed with files, rubbed or ground on emery paper of different fineness, and then polished. The polished surface showed practically nothing, and the true structure had to be developed by a suitable etching agent. For iron and some steels 2 per cent. nitric acid or a saturated solution of picric acid in alcohol were reliable etching agents; for copper and alloys rich in copper, ammonia (either strong or dilute), copper ammonium chloride and ferric chloride; for aluminium, hydrofluoric acid (especially when followed by nitric acid), and sodium hydrate; for soft lead alloys, nitric acid.

XUM

The action of the etching agent was one of selective attack, one constituent of the alloy being more readily attacked than another, and thereby brought into relief. Sometimes the "polish-attack" was used. This consisted of combining a polishing powder with the etching agent, and rubbing the specimen on the polishing pad wetted with the etching agent, until the structure was developed. One constituent was removed more rapidly than another, and the structure developed into a relief which showed bright and dark portions according as they were summits or depressions.

Another method of developing the structure was "heat tinting." The specimen was gently heated, whereby the different constituents of the alloy became tinted differently owing to the formation of a film of oxide of varying thickness, due to the different readiness with which, when heated, the various constituents reacted with the oxygen of the air.

When subjected to annealing, the metal or alloy underwent changes which depended upon the temperature and length of time of annealing. Electric furnaces of varying types were used. A simple form, which he had found extremely satisfactory, was made of a silica or unglazed porcelain tube wound with a length of nichrome wire, the length depending upon the size of the furnace and the desired temperature. It was most economical to make these furnaces so as to connect them directly to the electric mains, thereby rendering the heat generated outside the furnace as small as possible. The tube was well insulated with slag wool, asbestos, or other heat material, in order to avoid too rapid loss of heat by radiation, which would render the maintenance of a constant temperature practically impossible.

The specimens were placed in the furnace and kept at the desired temperature for a definite time, then rapidly removed from the tube and quenched, so as to fix the conditions reached at the particular temperature. If it was necessary to allow a similar specimen to slowly cool so as to follow the changes in structure brought about by slow cooling from a high temperature, and if the specimens were in the form of rod or wire, it was convenient to heat treat a length, which would be sufficient for the mechanical tests as well as for the microscopic examination. By those tests the alteration in properties with various treatments could be followed. The micro-structure could be obtained from the same specimen, so it was possible to correlate the mechanical properties, heat treatment and micro-structure, and to deduce the dependence of change upon the treatment. The composition of the specimen must be settled beyond doubt by the analysis.

From the data obtained the equilibrium diagram could be drawn. Taking the equilibrium diagram of the copper-zinc alloys known as the brasses, it showed the melting points of all mixtures of copper and zinc, the effect of cooling from the fused state, the effect of annealing at different temperatures.

Dr. Brislee exhibited a series of slides which had been prepared from photomicrographs of 60-40 alloys in order to determine the requisite heat treatment for large quantities of metal. He pointed out that one of the most important technical brasses, namely, Muntz metal, was shown in the cast state. It could be worked hot and cold, and it was customary to roll it hot, and then finish cold by drawing, whereby a very strong metal was obtained. In the cast state the structure was very indefinite, and depended upon the rate of cooling of the fused metal. Reheating, if carried out for a long time, caused re-arrangement of the crystals. When work, such as rolling or drawing was done upon such a metal, the crystals were deformed and elongated in the direction of work, so that a section across the direction showed a structure like a cross section of a bundle of rods. When a hard-worked piece of metal was annealed this condition of strain was removed, and the crystals tended to grow, the extent of growth depending on the length of time of annealing and the temperature. If the time of annealing was increased the size of the crystals became greater.

The examination of the pure metals themselves yielded a large amount of valuable information. By means of slides the lecturer showed the differences in the appearance of copper under varying treatment. He showed that when a cast copper ingot was rolled, distortion of the crystals occurred, the microstructure becoming finer and finer when such a metal was annealed. The deformed crystals tended to regain their original shapes, the extent to which they did so depending upon the time and temperature of annealing. A section of a hard drawn rod was shown in which a crystal had escaped deformation by the work; this was probably due to the work being too rapidly performed to completely penetrate. Another series of slides showed that the same order of effect held for aluminium.

These broad lines of work, Dr. Brislee continued, had been followed in the case of most metals, and the majority of binary alloys. In some cases the ternary and quarternary alloys had been partially investigated. The results obtained had very far-reaching effects. From the equilibrium diagram it was easy to decide upon the most promising alloy for any particular purpose, and the best line of treatment was indicated. It formed a valuable guide to predicting probable causes of failure, and indicated means for overcoming them. In other words, it defined limits and showed what precautions must be observed. Again, the equilibrium diagram showed what changes occurred in the solid state at various temperatures, and therefore what changes would occur when the alloy was working under conditions which allowed its temperature to rise

The micro-structure provided that the composition was accurately known, was a most valuable guide to the treatment, mechanical and thermal, which the metal had received, or in discovering the most suitable treatment for a particular metal. Systematic investigation had resulted in many alloys which formerly were only laboratory curiosities, becoming articles of general use. For instance, there were the alloy steels ranging from chrome steel—*i.e.*, rustless steel—to high-speed tool-steel and Hadfield's manganese steels, all of which were now in general use in engineering. The rapid progress of aeronautics had been made possible by the development of light alloys, starting well the work of Carpenter and Edwards,* and developed by many other workers, notably Rosenheim and Archbutt (tenth report, etc.). As a result, copper, zinc and aluminium alloys were now available, which had the strength of steel and a low specific gravity.

The following interesting figures were given by Dr Rosenheim in his recent Cantor lecture:—An alloy consisting of 3 per cent. copper, 20 per cent. zinc, and the rest aluminium, in the rolled condition had a tensile strength of 29 tons per sq. in., and would support a length of itself 9 miles long. Duralumin had a tensile strength of 27 tons per sq. in., and would support 9 miles of itself. A very high tensile alloy which had been developed for aeronautic purposes during the war, composed of copper, zinc, and aluminium, had a tensile strength of 39 tons per sq. in., and would uphold 12.6 miles of itself. Steel had a tensile strength of 30 tons per sq. in., and would only support a length of 3.7 miles.

It would require another lecture to even touch upon the progress that had been made with aluminium and its alloys. An excellent account would be found in Dr. Rosenheim's Cantor Lecture.† Thanks to this development aluminium was taking its proper place in the economy of commerce and engineering.

Enough has been said to show how patient and systematic work was yielding results, and it was now the duty of all those engaged in the metal industries to utilise those discoveries in every-day work. He advocated broader sympathy between the scientific worker and the practical man, and a clearer appreciation by each of the other's point of view. It was a happy omen that a Professor of Geology recently published a valuable paper on Casting Sands, a subject neglected in the past owing to the failure of the scientist to appreciate the great importance of this material, and the troubles which were caused when it was unsuitable. At the same time pure research must not be subordinated to practical considerations. When Joule and Thompson first investigated the fall of temperature which a gas experienced when passing through a minute orifice, thereby falling in pressure, it was a problem in pure thermo-dynamics.

* Eighth Report of the Alloys Research Committee of the Institution of Mechanical Engineers.

† "Journal of the Royal Society of Arts," vol. 68. Abstracted "Foundry Trade Journal," January 6, 13, and 20.

To-day it was the basis of modern refrigeration. Again, when Lodge and Hertz were investigating electric waves it was following out the theory of Clerk Maxwell on the electro-magnetic theory of light. To-day seagoing ships were equipped with wireless telegraphs, and it was impossible to overestimate its importance in peace and war. As a rule, it was impossible to say *a priori* whether any discovery would or would not be of practical importance. Its use might not be apparent to-day, but to-morrow it might be the foundation of what was required. But there were a multitude of technical problems awaiting solution, which had to be solved as soon as possible, and for this work, the experience, knowledge, and skill of both the technical men and the scientific worker were required. Let there be the freest exchange of ideas. One might have the information which the other required, and the two together would solve the problem which to each individually was insoluble.

Discussion.

MR. CRITCHLEY moved a vote of thanks to the lecturer. It was seconded by MR. HAIGH, who said the equilibrium diagram ought to be used in ferrous as well as non-ferrous casting. About two years ago the subject was dealt with by the present President of the Institution, and one would have thought it would have been taken up and developed. It certainly would be a great advantage to foundrymen.

The members were all more or less practical men, and Dr. Brislee had shown them the absolute necessity of getting into touch with the scientific side of the craft. It was only on those lines that progress could take place. Large firms whose foundries were well equipped could have their own staffs of chemists, but the smaller firms should co-operate in establishing a central laboratory where they would have the services of properly qualified men.

Dr. Brislee's suggestion that there should be broader sympathy between the scientist and the practical man appealed to him. The trouble had been that the scientist stood on too high a platform and did not come down to the level of the practical man. If they followed the example of Dr. Brislee and came down a little to meet the practical man, the latter would endeavour to move upward, and they would meet on common ground.

MR. SHERBURN, in supporting the vote of thanks, suggested that at a future meeting the members should discuss the question of cast-iron on similar lines to those on which Dr. Brislee had dealt with some of the copper alloys. Most of them were particularly interested in cast-iron. In dealing with it they had to bear in mind the fact that they were not starting with the elements but with a complex material. The problem was even more complex than with the copper alloys.

In replying to the vote of thanks, Dr. Brislee remarked that he believed in the freest exchange of views and appreciation of each other's point of view. That was the only way to make progress.

Quantity Production in American Foundries.

A meeting of the Sheffield and District Branch was held in the Cutlers' Hall, Sheffield, on Friday, November 19, when an interesting lecture on "Quantity Production in American Foundries," was delivered by Mr. H. Cole Estep, European Manager of the *Iron Trade Review*, Mr. John R. Hyde (Branch President), occupying the chair.

MR. ESTEP, who was very warmly received, said he felt it to be an unusual privilege to make his debut in England before such an important Branch of such a great metallurgical society as theirs. The contribution which British foundrymen had made to foundry practice was incalculable, and although on his side of the water they had the reputation of doing big things in the foundries, yet the fact remained that the modern art of making castings was developed in England, and he thought every man who was intimate with foundry practice recognised that, and furthermore, recognised the contributions to foundry science which were being made in this country.

He felt that he should warn them at the outset that he was not a foundryman. His experience as a foundryman—aside from a few months in his early days—was from the outside looking in rather than from the inside looking out. He had been connected with the publishing side which was very different from making castings.

In America they had collected some figures only last month relating to the foundry industry. These figures were collected twice a year and the latest figures showed that there were 5,982 foundries in the United States; 4,397 of which were grey-iron foundries. It was interesting to compare those figures with the British figures which had been officially supplied to him, and from which he observed there were 27,096 foundries or about two-thirds as many in this little country. Their concentration of casting plants was far greater than in America. In addition to the 4,397 grey-iron foundries in America, there were 242 malleable-iron foundries and 409 steel foundries. The annual production of grey-iron castings in America was four million tons. The average output on the average working day in America was only a little over three tons, so when gentlemen like their President and Mr. Firth went to America and were shown over different places they should remember they were the exceptions. The output was by no means as prodigious as a visit to some of the American foundries would indicate. In England the actual output he was informed was about 2¾ tons per day, so that there was not a great deal of difference between the two countries on that score. What he really hoped to do that night was, with the aid of a few lantern slides, illustrate to them some of the American foundry practices. These slides would be under three headings, (1) the welding of castings, particularly the welding of marine engine castings; (2) a brief survey of sand-blasting methods, and (3) moulding machines. The first group of pictures had really to do with war time welding. War themes might be worn out, but the slides might be interesting, and the technical problems involved in welding these castings were unchanged to-day. At the time the American Government declared war on Germany there were 105 German merchant ships interned in American harbours. They were seized and put into service again, but a month or two before the declaration of war instructions were given to the German engineers to destroy the machinery and make the vessels inoperative. The result was the boilers were damaged, and many other parts of the machinery were systematically broken. Half-inch holes were drilled in the low pressure, intermediate and high pressure cylinders and steam chests and pieces knocked out of them. They were so seriously damaged that the Germans believed they would be put out of service for the duration of the war. With characteristic German thoroughness too, they actually kept records of the nature of the damage done to each ship, and one such record found on one ship stated that they believed the damage done was irreparable. That did not prove to be the case, because with the electric arc or acetylene welding the 105 ships were again placed in service, and were carrying troops or munitions within about seven months after they had been seized by the American Government.

Proceeding, Mr. Estep then showed a number of slides of a number of foundry practices in America, which were followed with keen interest. At the conclusion of illustrations a number of questions were asked. Mr. Firth asked if it were customary in America to sand-blast grey-iron motor car cylinder castings.

Mr. Estep said it was very general. In fact they sand-blasted steel castings which was more difficult. By sand-blasting they got a nice silky sort of finish which was desirable. In foundries where valves, agricultural implements and motor-cars were made sand-blasting was very extensively employed.

In reply to another question by Mr. Firth, Mr. Estep said he had not been in the Ford foundry for five years. At that time the Ford people were melting 200 tons of iron a day, but at the present time he thought they were melting between 400 and 500 tons.

MR. FIRTH: I heard they were melting 1,200 tons.

MR. ESTEP: I don't think so.

MR. SHAW said the illustrations they had seen conveyed to their mind typical American practices. In taking output into consideration, it must be kept in mind the very different labour conditions

that obtain in America, particularly the large orders obtained. With regard to pipe plant, the author would admit there was little to be learnt from American practice, when he (Mr. Shaw) stated that both the lay-outs shown were of European origin.

COMMANDER JACKSON asked if there was much difference in the character of the sand as used in America and that used in British foundries generally.

MR. FEASEY, of Lincoln, recounted for the benefit of the meeting some of his experiences in America during a visit. In one shop he noticed from ten to a dozen men doing nothing else but repairing defective castings. It was done quite satisfactorily too. Very little was thrown away out of the fettling shop as compared with England. He though Mr. Estep had been very modest in what he had to say about production. What he (Mr. Feasey) had seen in that respect was wonderful. There was another marvellous but simple machine which gyrated the sand down a chute, and was thrown into the moulding box by some centrifugal device. This does away with all filling of moulding boxes with sand and the ramming.

The CHAIRMAN said that what struck him when in America was the wonderful variety of moulding machines. The Americans had evidently solved the problem of getting the engineers to pay a visit to their foundry shops. Most of these moulding machines displayed considerable engineering skill. In England the moulding shop was the last place engineers thought of visiting, whereas in America by their aid they were able to produce quite remarkable castings with unskilled labour.

In a general reply, Mr. Estep said he did not think the output in America was due to any inherent superiority, because, as he had said, in the beginning they were all agreed that the Old Country had laid the foundations of the industry. There was a combination of circumstances which made for that output, the chief one being, he thought, the excellence of the labour supply in America. It was more manageable. There were, of course, other conditions. With regard to the sand, it was very difficult to generalise. The vast expanse of territory in the States ensured different kinds of sands in different parts of the country, but he should say the sand used for grey-iron casting was about the same as anywhere else. In England they had any amount of natural bonded sand. In America a good deal of sands were mixed —they were more a manufactured product than natural. With regard to boards for the heavy jarring machines; that was a fairly general practice. They were tied together by cross battens sometimes 4 x 4 and sometimes 4 x 6.

MR. FIRTH, in proposing a vote of thanks to Mr. Estep, said it was very good of him to come down from London to speak to them. As he had told them, he was not a practical foundryman, but for a gentleman who was not, he had done very well indeed, and they owed him a deep debt of gratitude.

MR. WEBSTER, in seconding a vote of thanks, said he had been very much interested in what Mr. Estep had to say, and he thought he had handled his subject very ably indeed.

The vote was passed unanimously, Mr. Estep suitably acknowledging.

SCOTTISH BRANCH.

At a meeting of the Scottish Branch of the Institution of British Foundrymen, held at Glasgow on December 11, Mr. H. Williamson (Branch Vice-President) in the chair,

Mr. R. R. McGowan read a paper on "Cast-Iron Columns."

Mr. McGowan at the outset stated that the column was referred to at a very early period in the records of written history, and made reference to Hiram's work in the casting of the columns for King Solomon's temple.

The treatment of the column formed a most important study in architecture, and was dealt with under its three principal parts, namely, the base, shaft, and capital.

In classical architecture columns are divided into five distinct groups or orders, namely, Tuscan, Doric, Ionic, Corinthian and composite.

The first three were of Greek origin and the last two were added by the Romans.

Cast iron, owing to its high power of resistance under compression, made it a particularly suitable material for work in the nature of columns. It had also the additional advantages that it could be made ornate in form, which in certain circumstances was an important factor. Owing to these and other considerations, the column was a casting which presented itself with great frequency in many foundries, and especially in shops carrying on a trade in light castings.

Reference was then made to a system known as the divisional method of pattern arrangement, and an example was given showing that with eight pieces of patterns having the joints arranged according to this system, no less than 255 different lengths of columns could be obtained without having to pass the pattern through the pattern-shop.

The method of treating the core was also considered, and it was pointed out that the core boards were made in length to correspond with lengths into which the pattern was divided. The boards fitted into a specially made bench, the construction of which was explained.

The manner in which tapered and fluted columns were dealt with was also considered, together with the various methods of building the patterns.

Amongst other points associated with column work, consideration was given to the use of slotted boards, methods of preventing core barrels from sagging, warping of wood, alternative adhesive for patterns in place of glue, method of describing the entasis curve, the application of geometrical proportion to column work, method of moulding the capital, etc.

The lecture was illustrated by a number of lantern slides.

LANCASHIRE BRANCH.

Annual Dinner.

The annual dinner of the Lancashire Branch of the Institution took place on Saturday, January 8, at the Albion Hotel, Manchester, Mr. W. H. Meadowcroft presiding. The Lord Mayor of Manchester, Alderman Kay, was prevented from attending by the pressure of municipal duties, and in his absence the task of responding to the toast of the "City and Trade of Manchester" fell to Mr. Austen Hopkinson, M.P. In proposing the toast, Mr. W. H. Sherburn said Manchester was a great city in material things, but it had some leeway to make up in other directions. In order to keep its place the energies of its citizens must be given to making it a fit place for noble men and women to live in, and also to making noble men and women to inhabit it.

Mr. Austen Hopkinson, M.P., in replying, said he had been told by friends engaged in the trade of Manchester that for some weeks past the trouble had been, not that trade was bad, but that it did not exist, so far as the cotton people were concerned. In the engineering industry things were not much better. The foundry trade itself, owing to exceptional reasons, was not so badly off as other branches, but the outlook for the coming year, and especially for the spring, was extremely bad. We were now faced with one of the most difficult times that this country had ever experienced. Obviously it must be so, because for some five years practically the whole world was engaged in destroying all forms of wealth and producing next to nothing, and at the end of such a period trade depression was absolutely inevitable. The depression during the 'forties in the last century was probably ascribable in the first place to the prolonged Napoleonic campaigns of some thirty years before, but in these days things move much faster, and the effect of the war would be felt by the present generation. It was inevitable that the standard of living would come down. There was a silver lining to this cloud of trade depression which would come to some of the poorer members of the community. It was bringing the great democracy of this country to realise the truth of the situation. For ten years it had been repeatedly said that folly and vice and laziness could be met by a dole from the State. They had been acting on that advice, and the productivity of labour was now extremely low, so that it was

almost impossible to compete against any country whose inhabitants really worked.

Cast steel was now coming from Belgium at prices far below anything that it could be produced at in England, the lowness of price being due partly to the greater industry of the wage-earner abroad and partly to the rate of exchange, which gave other countries a great advantage in selling to us at the present time. No amount of Government action could correct that advantage and bring it over to our side, because the rate of exchange depended upon the balance of imports and exports, and the only way to correct it was to allow producers abroad to export to this country, to build up credits for them here, which would enable the British manufacturer to sell his goods abroad. What was essential was to get wage-earners to work. But it was only human nature that a man earning £4 or £5 a week would not exert himself to his full capacity if he saw that his increased productivity would add enormously to the profits of the employer. He therefore asked employers to consider whether it would not be wise to induce the wage-earners to give their best, by themselves refusing to take the full market value for their own services. At his own works he had introduced a system under which his own profits were strictly limited to an amount below the pre-war figure, and the men received their share of the profits week by week. The result was that the output had gone up enormously, and at a time when prices had risen extensively in every branch of the engineering world, the products of his works were sold at 50 per cent. above pre-war rates. He hoped other employers would consider whether they could not adopt a scheme on those lines for, at any rate, a few years.

In proposing the toast of the Institution, Prof. Rhead observed that in the past the foundry had been regarded as a place of hard work, grind and discomfort, shunned by the ambitious, the thoughtful, and the better-educated youths who entered industry. The foundry craft had not received the attention it deserved. Investigation had now cleared away pitfalls, and "haphazard" was no longer a term that could be justly applied to foundry methods. The Institution had brought men together to discuss the problems of the industry, and show how the knowledge now at their disposal should be applied. It had broken down the spirit of exclusiveness, and taught that theory and practice were not squabbling opponents, but closely wedded, and he hoped it would continue to work. It had been his desire for many years to provide a demonstration foundry at the Manchester College of Technology, and it would have been included among the proposed extensions. At present it was in abeyance, but he had not lost faith in the project, and he hoped soon to put forward a proposal which was feasible, but in which the co-operation of the members of the Institution would be essential.

Mr. O. Stubbs, vice-president of the Institution, replied. He said Mr. Keddell, the president of the Institution, was prevented from being present by the death of his father a short time ago. In the United Kingdom there were something like 2,796 foundries, and the Institution had a membership of, roughly, 3,400. They were to be congratulated upon having such a splendid membership. Employers and employés were able to come together without wrangling about wages or payment by results, and if there were more occasions when that could be done there would be a better understanding between them. A great deal of work had yet to be done in that direction, and it was desirable that a greater sympathy and better feeling should exist between both sides. If the foundries could be made more fit for boys to come to the difficulty of getting them into the industry would not be so great. Boys now received a better education than was formerly the case; although not of the age when they could select employment that called for master craft they could discriminate as to the better works and the better shops in which to work. Great strides had been made in the organisation of the Institution. The Royal Charter was within six or eight weeks of becoming an accomplished fact, and the members would then be able to use after their names the letters denoting the Institution. That in itself would be a very valuable reference when seeking employment. Then it would interest Mr. Rhead to know that an Industrial Research Department had been appointed for the grey-iron industry. The final meeting, held at Birmingham, was quite successful. The Institution was complimented on the work it had done. A good deal of the work which was to be carried out in works and laboratories would be applicable to practical, everyday purposes. Neglect of research and eudcation had a good deal to do with the inability to compete with the foreigner. The annual meeting and conference of the Institution would be held in Manchester in July, and he would occupy the chair as president. He asked the members of the Lancashire Branch to join in making that occasion a success; certainly the Council would spare no effort.

Mr. R. W. Kenyon proposed the toast of "The Visitors," which was responded to by Major W. Scholes, who expressed his surprise to hear that the Manchester College of Technology had not a proper foundry. That deficiency must be supplied. If the foundry people could not provide the money themselves they might at least give the equipment required. In his opinion wages would not be reduced, but there would be an improvement when the rate of exchange came down. They had got to stick it. They had had a good time, particularly the foundrymen, and they had to take the rough with the smooth.

A NEW ANTI-CARBURISING PAINT.—Messrs. Alfred Herbert, Limited Edgwick Works, of Coventry, have recently placed upon the market an anti-carbonising paint, which is used when it is necessary to strictly localise the effects of case-hardening. Any spot which is required to remain soft is merely covered with this anti-carburising paint, which prevents the carbonising of that particular place. When the hardening process is concluded the paint will be found to have fused to a glass-like substance, which can be removed by scraping or sandblast.

CAST ALUMINIUM BODIES.—Messrs. A. Harper, Sons & Bean, Limited, exhibited at the 1919 Olympia Show a cast aluminium body mounted on an 11.9 h.p. chassis. The body in question was constructed on the unit system, and consisted of a number of thin aluminium castings, ribbed where necessary by flanges, the scuttle panel, front near side door, side quarter panels, rear doors, rear quarter panels, back centre panel, and front seat casting, each being formed by a separate casting. The bottom portion for securing the body to the chassis was cast integral with the panels, felt packing being provided between it and the chassis frame. Two doors on the near side and one on the off side were provided. The upholstery was attached to wood fillets, screwed to the inner side of the casting, and when completed the body had precisely the same appearance as the ordinary wood and sheet metal type. This particular body was made throughout, including patterns, in their foundry and body shop. The sections were cast in sand moulds, the surface of the panels, which were about 3/16 in. thick, being quite smooth and clean, requiring very little polishing. Looking at it from a production point of view, it would be preferable to use die castings, as a perfectly clean surface would be obtained; also absolute uniformity of shape, making the assembly of the unit castings a very simple operation, and it would be a distinct step forward in the method of manufacturing motor car bodies.

CAST-IRON FOR LOCOMOTIVE CYLINDERS.—At the request of the U.S. Railroad Administration, the Bureau of Standards has investigated the mechanical, chemical, and microscopical properties of a number of packing rings furnished with service mileage records, as well as arbitration-test bars, chill-test specimens, and miscellaneous samples from different manufacturers. All of this material was cast-iron, such as used for the various cylinder parts. The Bureau of Standards at the same time made a review of the previous work and specifications on this subject, to ascertain as far as possible the practices of the different foundries, and to suggest such revision of existing specifications as would be warranted by the results of the present and other investigations. It was found that air-furnace iron is more uniform in character and in general of somewhat better mechanical properties than cupola iron. The latter, however, often equals or even excels the air-furnace product in mechanical properties. Because of the many variable factors it was difficult to establish correlation between laboratory and service tests. It was recommended, as a result of the present and other investigations, that the transverse-strength requirements of the standard American Society for Testing Materials 1¼-in. arbitration bar be increased from 3,200 to 3,500 lbs. for castings ½ in. or less in thickness, and from 3,500 to 3,800 lbs. for castings over ½ in. in thickness.

XUM

Moulding Impeller Castings.

By E. Longden.

The following describes a most rapid and economical method of moulding for such castings as shown at Fig. 1, A and B.

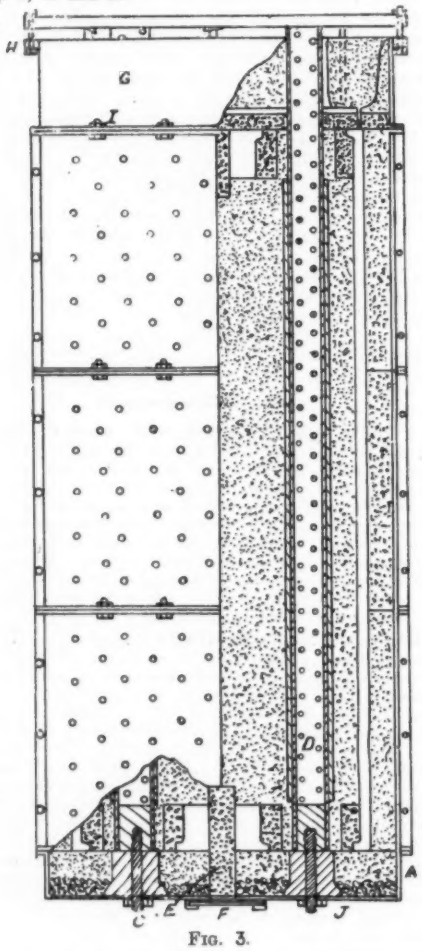


FIG. 3.

Instead of a full pattern and core box to form the mould and main core only a section of the shell, about a quarter of the total length of the intended casting,

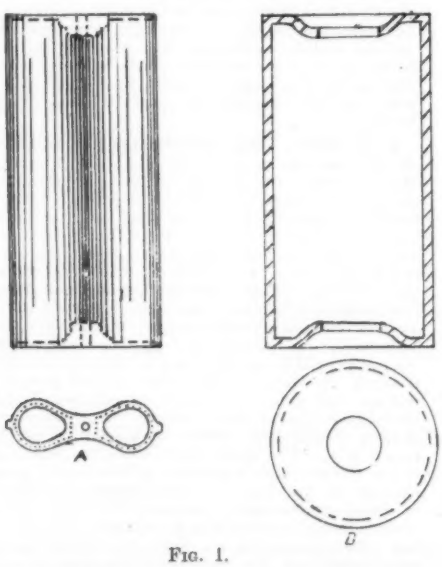


FIG. 1.

is needed, the object being to form the core at the same time as the outer mould. There are many designs of castings which can be moulded by this method, even more easily than the one here described.

Fig. 2 illustrates a shell pattern used for making large-sized impeller castings for Roots Blowers, shown at A, Fig. 1. As a rule large numbers of castings of this character are required, this allows the expense of an iron pattern. The shell pattern is conveniently moulded in two halves from one half wood pattern and bolted together. When made in this way the pattern is easily filed and trued up prior to setting together. A guide is made as shown at A, Fig. 2, and adjusted on the pattern to slide between other guides on the moulding box sides.

As each stage of ramming is completed the shell is drawn upwards, the movement of which is steadied by the guides.

Fig. 3 shows sectional elevation of moulding boxes and mould ready for receiving metal.

The bottom part of moulding boxes is shown at A, Fig. 3. It is shallow, but is strengthened with flanges which encircle the box. The flanges also hold good strong cotter-pins for registering the middle parts. The depth of sand or loam required in bottom part is about 4 or 5 inches; only a small portion of casting and runner gates rest on the bottom side of the mould. Bolt holes are provided at C to secure two strong cast-iron-perforated-core-barrels.

The barrels as seen at D, Fig. 3, are cast solid about 8 inches up from the bottom side and tapped to receive a strong bolt, which is used to secure the core bars firmly to the bottom part. The barrels act as vents and supports to the core, and are placed on either side of the waist of mould. A hole is allowed in centre of bottom box, shown at E, Fig. 3, to allow a round core, which forms hole for the revolver shaft, to be pushed up from underneath the bottom box when the mould is partly closed. The core is held in position by a flat plate, which is wedged and secured by two iron dogs bolted on the bottom, as shown at F. The middle box is made in two or more parts according to depth of mould: in this way it is convenient to construct the mould and allows the mould to be divided up for finishing and drying. Each part is strengthened with flanges and pinned similar to bottom box. The bottom piece of middle part is made with an internal flange in order to help to hold in the sand.

Fig. 4 is a plan of the middle boxes showing the arrangement of the guides at A for ensuring the straight draw of the pattern. Guides commence on the box sides at the height to which the shell pattern will reach when resting in its first position for ramming on the bottom face of mould.

It is wise to cast the middle boxes in halves and to bolt together; this enables an easy extraction of casting and sand from the box after pouring.

The design of the top box, shown at G in Fig 3, is similar to the middle parts, with the exception that it is cast in one piece. Its depth is made to receive the loam cake, set out in Fig. 5, and also to take the runner and riser basins which provide moderate head-pressure. Bolting-down lugs are provided at H, Fig.

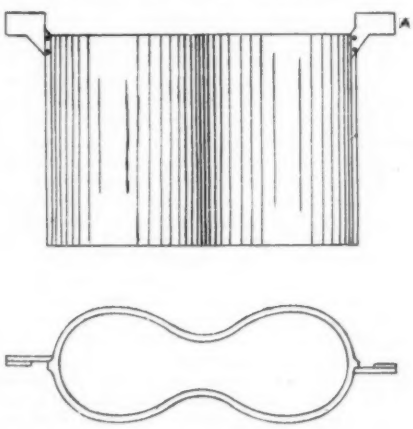


FIG. 2.

3, to receive stretcher bar, which holds down the top loam cake, and at I for bolting down to middle parts.

Such castings are conveniently moulded in pits. When moulding, the bottom box is first set on bearers

and raised sufficiently to allow the fastening of the core bars. Iron bearers, shown at J, Fig. 3, are set in the shallow bottom box to correspond with the bolting down holes for core barrel. Care is taken to set these bearers right down on to the iron bottom of box. They stand up level with the top of box, which is also the bottom side of mould. The remainder of bottom box is then rammed up with sand, or loam, and dried. A templet, as shown in Fig. 6, is made for the purpose of locating the print of the centre round core. Holes in templet fit the pins on the bottom box. One of the middle parts is then placed on the bottom box and the pattern set by the slides on the box sides.

Cores are set on the inside of pattern to form the internal flange and bearing metal for shaft which surrounds the centre core. The mould is cast by way of the waist opposite the thick metal in the bearing,

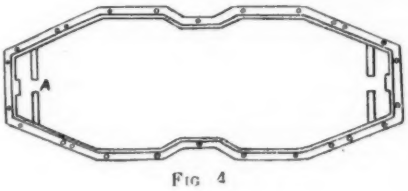


FIG. 4

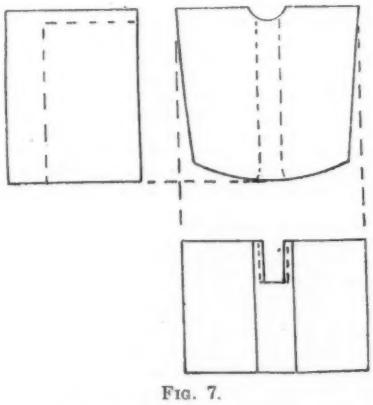


FIG. 7.

and augmented later by top drop-gates. The cores, shown in Fig. 7, are made to form the runner at the waist. Core bars are next placed in position and firmly secured by bolts through the bearers and bottom boxes, as previously described. Advantage is taken of the middle part to steady the vertical core bars by wedging them to the sides until the rammed sand and irons lend additional support. The cores which form the internal flange and bearing must be strong; they encircle the two upright core bars. A good clearance is needed on the inside of these cores to allow sand to be rammed around the core bars to seal and strengthen the joint and mould. The construction of the mould is continued in the usual manner, care being taken to tie together the core bar and sand by encircling the material with irons at intervals in the ramming. Hay bands must be wound round the barrels and venting helped by the addition of cinders and the vent wire. The pattern is drawn upwards as each stage of ramming is completed. The bars illustrated in Fig. 8 are rammed up, one on each side of the core-bars; they help to stay the sand and extend from the cores on the bottom of mould to similar cores reversed to form the internal flange and bearing at the top end of mould. These bars are also used to determine when the shell pattern has been fully drawn to form the desired length of casting. A nick on each core bar is a further check for ascertaining the length of the mould. On the outside of mould two or more joints are made to allow ease in trimming and finishing. The top of mould is sealed by a loam cake (Fig. 5), which contains the runner and riser openings. It is a simple matter to break the mould at the joints and finish off quickly: the core is left standing in its entirety on the bottom box. Obviously the mould will be easily dressed, as there are no awkward repairs to make. When finishing off the outer and inner moulds are completed, the outside is once more placed in position on the bottom box and lifted about 3 inches and supported on four iron bearers under the edge of box. Gas jets, or other drying devices, are then introduced at the bottom of mould through the openings thus made, and the mould is dried in the pit as it stands.

The mould is very quickly closed. The round core is pushed up from below the bottom box into a print in the main core as described above, and the joint round the core is sealed with loam, the core being secured by a flat plate fastened to bottom box. The round core, similar to the one in the bottom, is placed in position on the top side of mould and the loam cake, forming the top side of mould set in its place. Care must be taken to fasten down the loam cake by ramming bearers up along with the sand to form the runners and risers. The tops of the bearers are secured to a bar stretched across the top box and fastened by the lugs provided on the top box. Runner and riser gates are made up inside the box, plugs are placed in position, and the mould poured.

The casting shown at B (Fig. 1) is much simpler to mould than the revolver. With a good body of sand in the core, much of the strengthening and supports can be dispensed with, but the principle of its moulding is virtually the same as A (Fig. 1).

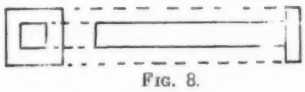


FIG. 8.

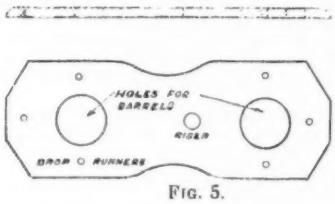


FIG. 5.

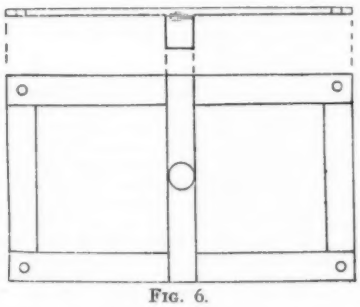


FIG. 6.

It is a quick method moulding, and it has been known to cut down the cost of such castings by 30 to 40 per cent. It produces a very superior casting of correct section.

Oxweld engineers recommend the substitution of bent piping for the straight piping. The theory as to contraction control was tested on both the straight and the bent pipe. Accordingly a heavy cast-iron jig was made, to which the drums were made fast in the proper position with heavy bolts. The contraction when the straight pipe was used was so powerful that the bolts were sheared off by the pull on the drum, the contractions amounting to several inches. When the bent pipe was used instead of the straight pipe this did not occur, the bent pipe accommodating itself to the contraction so completely that when the drums were removed from the jig they were found to be in correct position, fitting perfectly with the mating pairs.

MOULDING SMALL STEEL-CASTINGS. — In a Paper before the American Foundrymen's Association, R. J. Doty, Sivyer Steel Casting Company, Milwaukee, Wis., stated that while all foundrymen were agreed that a good facing sand should be strong, open or porous, few will agree on the ingredients to be used or the methods of mixing. The author said that a mixture which he had found to give very good results under varying conditions and with different grades of silica sand and clay in the production of green sand castings was made up of 216 parts of floor sand, 24 parts of new silica sand, three parts of fireclay, two parts of foundry flour, and four parts of silica flour. The question of facing was the most important the foundrymen have to deal with, and he attributed this to the fact that sand mixtures are not watched with the same care as is bestowed upon the metal. In discussing the Paper, Mr. Doty said that all kinds of sand were employed in the mixture described and found equally good. When the old sand becomes close it is opened up by using new sand. Some suggestions for sampling sands were made, and it was the general opinion that daily tests of sand ought to be taken. The use of the microscope in selecting materials for foundry use was strongly advocated.

Aluminium Castings.

By F. A. LIVERMORE, M.I.M.E.

Aluminium, as a casting material, presents the advantages of lightness, good machining properties, a fair amount of strength and freedom from brittleness. The widespread adoption of aluminium alloy castings of recent years sufficiently demonstrates their reliability to withstand great strain under severe conditions.

It is well known that pure aluminium is too soft to produce satisfactory castings, which will be subjected to any strain, owing to its comparative softness and lack of strength, and to overcome this it is the universal practice to stiffen up the metal with some hardening element, the amount and nature of the hardening element or elements depending on the physical and mechanical properties required.

Probably the most widely used hardener for aluminium is copper, which is used at the rate of about 8 per cent. of copper to 92 per cent. of aluminium. Zinc, tin, nickel, etc., are also frequently used as hardeners. The use of these is attended with some well recognised objections.

The addition of from 8 per cent. to 10 per cent. of hardener partially defeats the purpose of using aluminium, in that the specific gravity is materially increased.

The hardened metal, whilst fairly strong, has a strong tendency to brittleness, and the alloys are, in most cases, less resistant to corrosion than either of the component metals.

However, for the purpose of casting kitchen utensils and similar material, where resistance to corrosion is of greater importance than tensile strength, a small per centage of manganese (between 0.1 per cent. and 0.5 per cent.) is added, which greatly facilitates casting.

Manganese in relatively small quantities hardens and strengthens the alloy without destroying the ductility: the machining properties are excellent, and when properly moulded the most intricate casting can be produced free from hot-shortness with comparative ease.

In a paper given by Dr. Rosenhain* at the Royal Society of Arts, the lecturer spoke of the great benefits gained from the use of aluminium pistons in internal combustion engines, owing to its high thermal conductivity and relatively light weight in comparison with iron and steel. He stated that an alloy of 88 per cent. of aluminium to 12 per cent. of copper gave a poor tensile strength at high temperatures, but the addition of 1 per cent. of manganese greatly improved this.

Practically all the standard aluminium alloys can be successfully cast. The two main classes of aluminium casting alloys are:—(1) Hardened zinc alloys with or without small percentages of other elements; (2) copper hardened alloys.

Class 1 is extensively used in British aluminium foundries, whilst the copper alloy is favoured by the French and American foundries.

Aluminium-zinc alloys have the reputation of being particularly subject to fatigue; this is due to the weakening effect of certain impurities of commercial spelter. Lead, in particular, is very deleterious to any aluminium alloy, and when castings of the zinc base alloy are required to pass severe physical tests, only high grade zinc should be used.

Other dangerous impurities are carbon, silicon, and iron, and the greatest precaution should be taken to prevent the introduction of this foreign matter, either in the metal used or through the medium of crucibles and tools.

In melting aluminium alloys, plumbago or salamander crucibles (preferably with clay-liners) should be used.

The melting is preferably carried out in a gas-fired furnace, using a mixture of air and gas, which can be adjusted to prevent overheating and subsequent burning of the metal. Messrs. Bowen & Edwards, of Birmingham, are marketing an electric furnace for non-ferrous work, which they claim is much more reliable and cheaper than the gas furnace or other type of furnace. The United States have already made much progress in this direction.

No charcoal or carbonaceous covering should be used on the metal, as carbon combines with the alloy, forming a very brittle constituent.

Gates and sprues from castings, before being remelted, must be freed from sand, as this material is reduced to silicon, which weakens the alloy.

In cases where there is danger of introducing sand, it is found beneficial to add a powdered flux, consisting of 75 per cent. of potassium chloride and 25 per cent. fluorspar. Such a flux tends to dissolve the silicon and so keep it from combining with the aluminium.

* See January 20 issue of the "Foundry Trade Journal."

A tough film of oxide often surrounds borings, turnings, chips, and other scrap aluminium, which makes it extremely difficult for melting. This oxide can be dissolved off by heating with the alkali earths, and the following process is recommended by the British Aluminium Company:—

The oxidised scrap is intimately mixed with varying amounts of a flux, consisting of 85 per cent. of common salt and 15 per cent. powdered fluorspar, depending upon the degree of cleanliness of the chips, and the whole is melted at a fairly high temperature. Special precaution should be exercised when melting the heat to prevent overheating, as this appreciably affects and is injurious to the working properties of the casting.

The pouring temperature has a very noticeable effect upon the resultant castings. In general, the temperature should be as near the melting point as possible. After a considerable amount of research the author has found, by adhering to this rule, an increase of four tons per square inch in tensile strength is obtained, together with a marked improvement of the surface appearance of the casting. The temperature recommended is 650. deg. C., plus or minus 10 degs.

In quite a number of foundries the archaic method of guessing the temperature by the eye is still in vogue, and undoubtedly a large percentage of the unsound work produced is due to this. All aluminium casting should be under strict pyrometric control to obtain satisfactory results: the outlay for such an installation is quickly returned by a corresponding increase in sound production.

Just before pouring a little flux, which tends to reduce the oxides and dross in the metal and to put it in ideal condition for pouring, is added to the molten mass. The metal is thoroughly stirred with a clay-covered skimmer, otherwise the heavy oxide which is occluded throughout the mass would cause blowholes. The dross which forms on the surface must be removed with special care, the skimming being done with a degree of thoroughness as to obviate any dross remaining under the surface and passing into the casting.

The aluminium casting has a characteristic cleanliness when removed from the mould and very little dressing is required. In grinding off any fray, workmen often find that the emery wheel has a tendency to gather particles, which interfere with the grinding. A little lard-oil or grease on the surface of the emery wheel will prevent this clogging and will ensure smooth working with maximum efficiency.

The difficulty of welding aluminium has been satisfactorily overcome by treating the surface to be welded with a mixture of four parts of potassium chloride, three parts sodium chloride, and one part of sodium fluoride with a melting point of about 660. deg. C. Cracks, shrinkholes, pinholes, or other defects can be repaired by means of an oxy-acetylene blowpipe: and the repaired casting is quite as reliable and strong as a sound one.

In connection with his work on alloys of aluminium, the writer has found the laboratory an indispensable asset. The co-operation on the part of the chemist has elucidated difficulties which may otherwise have been left unsolved, and in consequence a simple set of processes is given for the rapid analysis of aluminium and its alloys which may prove useful to works laboratories.

These processes have been standardised in the laboratory of Messrs. Lavender & Whitehouse, Limited, of Wednesbury, by the author

Analysis of Aluminium.

Estimation of Copper.—Two grs. of the drillings or turnings are dissolved in 50 ccs. of 1 in 8 HCl and are digested for one hour on a hot plate. The residue is filtered off, the filter paper is washed well with 10 per cent. HCl., and then freed from acid with distilled water. The residue is washed into an electrolysis beaker with water and is dissolved with about 2 ccs. of HNO_3. Sp. Gr. 1.2.

The solution is diluted to about 150 ccs. with water, and is electrolysed at 3 amp. 3 volts, using a rotating electrolysis machine.

The cathode is quickly removed from the machine when the deposition of the copper is complete and is washed in water, then alcohol, and finally dried in a hot-air bath at 100 deg. C.

From the weight obtained the percentage of copper is calculated.

Estimation of Iron.—One gr. of the allow is weighed into a 400 cc. conical flask covered with a watch glass and dissolved in 25 ccs. of 25 per cent. NaOH solution. When the action ceases, warm 25 per cent. H_2SO_4 is added until the precipitate formed just dissolves up, 2 ccs. in excess are then added to make the solution slightly acid.

The copper is filtered off and the filtrate is titrated with deci-normal potassium permanganate solution.

1 cc. $KMnO_4$ = .00559 gr. Fe.

Estimation of Silicon and Silica.—One gr. is dissolved in 20 ccs. of aqua regia. When dissolved, a little H_2SO_4 is added and the whole is heated until SO_3 fumes are given off. Cool and take up in dilute HCl. The silica is filtered off, washed well with distilled water, ignited in a platinum crucible, and weighed as SiO_2.

To estimate silicon, add HF to the contents of the crucible, heat and ignite and re-weigh. From the weight obtained the percentages can be calculated.

Estimation of Nickel.—Two grs. are dissolved in HCl and a little HNO_3. The solution is well diluted with water and 10 grs. of tartaric acid are added, the whole being thoroughly stirred until complete solution is obtained.

The solution is made slightly ammoniacal and a few ccs. of a 1 per cent. solution of dimethylglyoxime are added, the whole being well stirred and allowed to stand. The nickel-glyoxime is filtered, washed well, and estimated in the usual way.

Estimation of Manganese.—1.1 grs. are dissolved in 25.30 ccs. of HNO_3 (Sp. Gr. 1.2) and a single drop of HF is added. When dissolved the excess of acid is boiled off and the solution is oxidised with a little sodium bismuthate. Dilute H_2SO_3 is added until the solution is clear; it is then cooled to room temperature.

More bismuthate is added for oxidising purposes and the excess is filtered off through an asbestos pad. The filtrate is titrated in the usual way, using $FeAmSO_4$ and $KMnO_4$.

Estimation of Magnesium.—Two grs. are dissolved in 100 ccs. NaOH (15 per cent) in a 500 cc. tall spouted beaker. When the first effervescence is over, the solution is boiled for a few minutes, diluted to 300 ccs. with water and boiled again. The residue of copper, iron, nickel, manganese, magnesium, and a little aluminium is allowed to settle for a few minutes and then filtered off and washed well with hot water.

The filter paper and residue are returned to the original beaker together with 10 ccs. HCl (Sp. Gr. 1.1) and 10 ccs. HNO_3 (Sp. Gr. 1.2) and heated over a hot plate. When dissolved, dilute a little, filter and wash the filter paper with warm MCl (Sp. Gr. 1.1) and hot water. The bulk of the solution is kept low, and then 10 ccs. of concentrated H_2SO_4 are added and the whole evaporated until SO_3 fumes are evolved.

The mass is cooled, diluted to 200 ccs. with water, and the copper is precipitated with vigorous current of H_2S. The precipitate is filtered off and washed well with H_2S water. The filtrate is boiled to free it from H_2S, and is then oxidised with a few drops of HNO. (Sp. Gr. 1.42) and reboiled. About 3 grs. of NH_4Cl and excess of NH_4OH are added. At this stage it is important that any aluminium existing in the solution be precipitated with the iron or it will later contaminate the Mg.

The hydroxide of Fe and Al are filtered off and the filter paper is washed well with hot water. To the practically neutral filtrate 2.5 ccs. of NH_4OH (Sp. Gr. 0.88) is added; it is then heated to about 70 deg. C. and saturated with H_2S. The Ni and Mn sulphide are filtered off and washed well with water containing (NH_4) S. The filtrate is acidified with HNO_3 (Sp. Gr. 1.2) and is boiled down to low bulk. Any sulphur that may be precipitated is filtered off. To the filtrate 20 ccs. of a 10 per cent. solution of ammonium phosphate are added and the solution is neutralised with NH_4OH, then with constant stirring, one-third of its bulk of NH_4OH (Sp. Gr. 0.88) is added, and the whole is allowed to stand for 12 hours.

The precipitate is filtered off, thoroughly washed with 5 per cent. NH_4OH, dried, carefully ignited, and weighed as magnesium pyrophosphate ($Mg_2P_2O_7$).

Estimation of Tin.—Two grs. are dissolved in 1.2 HNO_3 (Sp. Gr. 1.2.) and boiled down to low bulk. It is then diluted with water and filtered. The washed residue is ignited in a platinum crucible and weighed. The contents are treated with HF, to eliminate the SiO_2, until constant in weight. The remaining is weighed as SnO_2.

As an alternative the oxides of Sn and Si may be fused with NaOH, HCl is added to dissolve the cake, and the solution is evaporated to dryness. The silica is filtered off, and the tin is precipitated as sulphide and estimated in the usual way.

Estimation of Zinc.—One gr. of the alloy is dissolved in 50 ccs. of HCl (1 in 4). When all the aluminium is dissolved, the copper is filtered off, and to the filtrate is added 50 per cent. NaOH until the precipitate, on formation, is just taken up. Add 20 ccs. of the solution in excess.

The solution is diluted to 500 ccs. and a quick stream of H_2S is passed until the zinc and a little aluminium is precipitated. The sulphides are filtered off and washed with Na_2S and boiling water and then dissolved in HCl (Sp. Gr. 1.1).

The H_2S is boiled off; all the Fe and Al is precipitated with NH_4OH in presence of NH_4Cl. The precipitate is filtered off, re-dissolved in HCl. The Fe and Al (with a little zinc) are precipitated again and the filtrate added to the first. The filtrate is made just neutral, using methyl orange as indicator and about 20 ccs. of a 10 per cent. solution of ammonium phosphate are added. The zinc phosphate is filtered off, washed well, and estimated as usual.

A Modern Foundry for Producing Small Castings.

The new foundry of the Elmira Foundry Company, Elmira, N.Y., recently described in "The Iron Age," was designed particularly for the production of small castings for fractional horse-power-motors. The foundry has a maximum capacity of 250 tons per day. Castings weighing from ½ lb. to 500 lb. are being made in the new foundry, the two old foundries being used for the production of larger castings.

A predominant feature is the use of electric storage-battery trucks for the handling of molten metal and castings, electric travelling cranes being eliminated with the exception of one crane in the cleaning department.

The design of the new foundry not only provides for economical operation, but also for the comfort of the workmen. The main plant is 560 ft. long and 120 ft. wide, and has only one row of interior building columns, these being in the centre and dividing the foundry into two 60-ft. bays. The roof is carried by 60-ft. trusses supported by columns on 20-ft. centres. The structure is of good height, being 24 ft. 6 in. clear from the floor to the trusses. The roof has an unusually large V type monitor, 60 ft. wide, extending nearly its entire length. In the sides of the monitor are two 5-ft. continuous sections of top hung sash. In the side walls there is a 3-ft. 10½-in. pilaster back of each building column, and between the pilasters there are window sections 16 ft. 1½ in. wide and 24 ft. in height. The windows extend above the trusses to 3 in. below the roof line in order to admit the maximum amount of light. The sashes are of the Lupton type and are fitted with factory ribbed glass.

A feature not common in handling equipment in foundries is the installation of hand-operated cranes having 20-ft. spans and equipped with 2-ton air hoists in each bay and running across the bay parallel to the roof trusses. The crane rails are suspended from the panel points of the trusses, a distance of 9 ft. 6 in., making the height of the crane rail 15ft. This height permits a minimum hand power required to pull the crane and its load. The suspension of the crane runway is by means of hangers made of two 4 × 3 × 5/16-in. angles that support a 6-in. I beam. The crane rail rests on the I beam, to which it is fastened by hook bolts.

The two cupolas and charging floor are located in an extension on the east side of the building. The cupola room is 36 × 40 ft. and is inclosed by a brick wall 13 in. thick. The charging floor is 30 × 80 ft., providing ample room for the storage of loaded charging cars. One cupola is 72 in. and the other 54 in. in diameter inside the line. The cupolas were furnished by the Whiting Foundry and Equipment Company.

Metal from the cupolas is run into mixing ladles. The management has adopted the practice of pouring first into a large ladle and then into a smaller one to insure a thorough mixture of the molten cupola charge. A 3-ton mixing ladle is used with the large cupola and a 2-ton mixing ladle with the smaller. From the mixing ladle the metal is poured into a 1-ton ladle mounted on a ladle standard and platform that rests on the electric truck which is used to carry the ladle to the moulding floor. The standards are so designed that the truck platforms can be run beneath them and pick up the ladles and deposit them on the foundry floor. These standards will also be run on casters so that they can be pushed about the floor.

From the aisle at the side of the moulding floor the ladle is lighted from its standard with air hoist and crane which move it along the foundry floor for pouring, or the metal is first poured in small hand ladles. The smallest castings are made in the west bay, which is not provided with overhead cranes, and here the pouring is all done with hand ladles. The mixing ladles and the truck ladles are of the Whiting worm gear type.

The electric trucks are of 2-ton capacity, and were supplied by the Automatic Transportation Company. Two trucks and about a dozen ladles are used. The trucks are also employed in carrying castings to the cleaning room and for other handling work. Wooden platforms 5 ft. long and 4 ft. wide are provided for use in connection with trucks for taking castings to the cleaning room.

XUM

Electric Furnaces and the Sulphur Problem in Cast Iron.*

By GEORGE K. ELLIOTT.

Last year the author read two Papers, "Improving the Quality of Grey Iron by the Electric Furnace," Transactions of the American Electro-Chemical Society 35, 175-181; "The Electric Furnace as an Adjunct to the Cupola," Transactions of the American Foundrymen's Association 28, 352-361, dealing with the then widely unfamiliar subject of treating cast iron in the electric furnace. He described, for the purpose of obtaining more highly superheated and more thoroughly refined iron, a duplex or tandem process that consisted of first melting the iron in the usual way in a cupola furnace and then transferring the molten metal to an electric furnace with basic bottom where it was superheated and refined under a basic carbide slag. Inasmuch as this rigorous refining brought about, among other results, a very marked reduction in sulphur. The subject of low-sulphur cast iron thereafter took up a considerable part of the author's metallurgical life, conversation and correspondence. For it seems that about the same time Dr. Moldenke was announcing far and wide that iron foundrymen all are face to face with a sulphur problem that, snowball-like as it rolls down along the years, is acquiring a size and direful aspect that is liable to require a serious investigation almost any time, if one does not want to see the whole iron foundry business eventually swamped by the sulphur that is steadfastly mobilising itself in the world's scrap-iron pile.

The author confesses to his indifference to this sulphur menace at the time of his papers on account of his recent experiences all having been in a foundry employing only low-sulphur pig-iron and coke and no scrap iron of outside origin. However, Dr. Moldenke's well-timed remarks anent the subject directed considerable attention to the electric-furnace desulphurising process described in the two papers mentioned and before long the author found himself a veritable question-box for inquiries about not only the process but also about the effect of sulphur in cast-iron and more particularly about iron very low in sulphur such as was described in the papers. Presumptuous and entirely fruitless would it be for me to attempt an answer to the many questions hanging upon this point, but it is my intention to make this brief paper a general statement of the broader facts connected with low-sulphur cast iron and the process by which it can be obtained.

The chief count against sulphur in cast iron seems to be that it is a non-metal pre-empting a place among real metals, a bold pretender, a counterfeit. This it has been able to do by taking on the semi-metallic semblance of the sulphide of a metal; but all the time the foundryman has never lost sight of the fact that sulphur in the form of a sulphide, be it iron sulphide or manganese sulphide, still is a non-metal and not entitled to an important or vital place in the metal structure.

In plain unfigurative language, sulphides in cast iron break up the metallic continuity of the mass by freezing last, thereby being enabled to collect in veins along the joints between adjacent crystals of iron. This is true even of so small amounts of sulphur as below 0.05 per cent.; but we are little bothered or concerned by so slight effects. However, when the sulphur content of cast iron gets to be more than 0.05 per cent. it shows a most remarkable tendency to segregate in spots in a way that is liable to increase the harmful effects beyond all numerical proportion.

By this it is meant that 0.15 per cent. sulphur will harm cast iron through the increased tendency to segregate, more than three times as much as will 0.05 per cent. sulphur. The writer's estimate would be that the evil would aggregate at least three times three times.

It is this sure tendency to segregate that in my judgment constitutes the greatest menace of high sulphur. Occasionally there is a foundryman learned, experienced and clever enough to make occasional high sulphur iron castings in which the sulphur is uniformly distributed throughout the metal; in such cases there always is widespread wonder at the unexpectedly good quality of the metal so rich in sulphur. Here the word "good" is used advisedly and only relatively. Except when certain well defined qualities such as hardness are required and can be attained by no other way, a low-sulphur iron will outshine a high-sulphur one when the full inventory of really worthy qualities is taken. By low sulphur in the preceding sentence I mean *practical* low sulphur of 0.05 to 0.075 per cent., or sulphur scant enough to be incapable of *serious* segregation.

* From a paper presented at the annual convention of the American Foundrymen's Association at Columbus, Ohio, Oct. 5. The author is metallurgist with the Lunkenheimer Co., Cincinnati, Ohio.

Low Sulphur in Electric Steel.

However, the basic electric furnace process that was described in the papers mentioned, often produces sulphur so far below 0.05 per cent. that the question is raised as to the advantages accruing from sulphur as low as 0.020 per cent., for example. In this connection one heat can be cited that emerged from the tandem process with the sulphur so far eliminated that it took a gravimetric analysis in the laboratory to discover the 0.009 per cent. that constituted the remnant.

To return to the question as to the advantage of so low sulphur, academically it can be answered that the amount of non-metallic intercrystalline film breaking up to some extent the solidarity of the metal mass, is definitely reduced to a minimum that formerly was capable of expression only on paper and not in fact. Practically answering the question, it must be admitted freely that in the present state of testing and measuring the qualities of cast iron we are unable to fix positively any pronounced advantage in grey iron castings with 0.015 or 0.030 per cent. sulphur, over those with twice those amounts of sulphur. However, there is a sort of speculative satisfaction and assurance in knowing that limits can be and are being achieved in every day practice that certainly are safe beyond all shadow of doubt: that the danger line at least is put a long way off. Possibly a more material advantage in this extremely low sulphur is the fact that the degree of desulphurisation can be taken as a very reliable gauge of the amount of general refining that has taken place in the metal bath, having in mind particularly deoxidation and degasification.

Another rather indirect but very significant benefit derived from low-sulphur in cast iron is a certain independence from high or moderately high manganese. One of the reasons for the presence of this last element in cast iron is the neutralisation of the evil effects of sulphur, through preventing the formation of pernicious iron sulphide by forming manganese sulphide in its stead. Frequently iron is overdosed with manganese merely to take care of anticipated high sulphur and not seldom is the surplus manganese sufficient to increase the hardness and correspondingly decrease the machinability of the castings. If the metal is known to be very low in sulphur, the manganese may be used more sparingly, with a saving not only of manganese but of machine shop finishing costs.

Low Sulphur, Less Manganese.

The fact has indeed been noticed that electric furnace refined iron with low sulphur will be harder than cupola iron of the same silicon, combined carbon and manganese content and higher sulphur. This probably is because the manganese, relieved almost entirely of the charge of policing that bad character sulphur, is released to other activities and so goes to work forming double carbides with iron and carbon which has the effect of increasing materially the hardness of the metal. The differences in hardness probably would not be measurable or even noticeable in large castings, but that it is distinctly manifest in small ones he can aver from repeated experiences. Also this question of hardness is intermingled with the closely related subjects of the increased attraction of high-manganese irons for carbon, and of the protective influence of high manganese against oxidation in the cupola, both of which have a very considerable bearing upon the subject of hardness.

Instead of striving for and accomplishing the low sulphur limits that have just been mentioned it is entirely probable that the more popular practice will be to resort to the use of more scrap or of pig-irons running higher in sulphur, for example, making mixtures coming from the cupola with 0.120 to 0.150 per cent. sulphur or even more, and by duplexing in a basic electric furnace reducing that element to about one-half. In the finer grades of iron foundry work so great a reduction of sulphur as this would show benefits that would be practically demonstrable. It is undeniably possible to improve the general qualities of really high-sulphur cast iron by desulphurisation. The more abundant widespread use of scrap is rapidly becoming not only an economic duty for the sake of the conservation of our raw materials, but also in this time of high freight rates, a well defined need. Here we have a distinctly useful application of the basic electric furnace for rendering fit for service scrap that normally is more or less unfit on account of its accumulation of sulphur.

In closing the author wishes to emphasise the reducing or deoxidising nature of the reaction by which desulphurisation is accomplished in this electric furnace process. By it getting rid of sulphur is made a double blessing: and who knows what and how many of the virtues of basic electric furnace iron are in reality due not only to low sulphur but also, and perhaps to a much greater degree, to the chemically *deoxidising* influences by which it has been refined?

IRON AND STEEL MARKETS.

Pig-Iron.

Usually a difficult period of the year in the pig-iron trade, January on this occasion has been an exceptionally trying time for both producers and consumers, approaching, perhaps, as near as possible to a complete standstill as regards the actual volume of business transacted. The continued inactivity of demand in almost every branch of manufacture in which iron is an indispensable essential, has had, and is having, a paralysing effect upon the smelting industry in general, as told in the closing down of numerous producing plants in the various districts, while the foreign export trade can no longer be regarded as an alternative outlet for the surplus stocks accumulating in makers' yards. The much prescribed remedy for these conditions—a reduction in the cost of production—seems meantime as far off as ever, and though some small measure of relief in that direction has been achieved by some concessions in fuel prices, the result has hardly been satisfactory regarded as a stimulus to increased buying. Following the example already set by the Midland coke interests, fuel producers on the North-East Coast, as expected for some time, last week decided upon a reduction of 3s. 3d. per ton, making the quotation for good medium furnace qualities 59s. 6d. per ton at ovens, with descriptions lower in phosphorus, 62s. On the principle that every little helps, this movement is in the right direction, but is still quite insufficient when contrasted with the Midland coke makers' figures. In the Cleveland market, though a better attendance is now reported, attempts to do business are mostly pressed by sellers, the majority of consumers adopting the usual policy nowadays of waiting for a more definite movement towards much lower levels in values. As a preliminary stage towards re-establishing confidence, it is satisfactory to record that last week the Cleveland ironmasters agreed to accept in all future contracts a fluctuating price clause, giving the buyer the benefit, upon any unexpired portion of his contract, of any future reduction in price. The stipulations previously in force in pig-iron contracts have long been a source of grievance with consumers, and the more equitable terms now offered should be effective in stimulating more substantial buying on forward account. There remains, however, one difficulty—the application of the new clause as concerns running contracts—to which has not yet been extended the advantages of the new terms, many merchants complaining that they have been unduly penalised in the past when advances have been made subsequent to the acceptance of the arrangement. Another inducement for buyers holding off is the widely entertained idea that prices have not as yet by any means touched bottom levels, and with a consistent drooping tendency there is some justification for this attitude. The policy is, however, completely prejudicial to legitimate business, which is consequently, more or less, conducted on hand-to-mouth methods. With the assurance from smelters already outlined, buyers can proceed more confidently, the knowledge that any further drop in prices will at once receive recognition in standing contracts inspiring some expectation of an immediate expansion of forward business. Shipments of pig-iron from Tees-side, already recorded for this month, illustrate the slackness of the export trade, the total to date only amounting to some 2,170 tons, as compared with 4,940 tons for the corresponding period of December. This decline may, perhaps, be explained in the fact that the premiums are still retained in regard to the export of foundry and forge iron, and only very small quantities are being sold, the disorganised state of the Continental exchanges heavily handicapping British traders. The lire, for example, is now over 100 to the £, and Italy is consequently out of the market. The franc in Paris, too, is over 50, and the Belgian franc about 55—quotations which render business difficult, if not impossible. There has been no further change in Cleveland iron quotations, which are officially returned as follow:—No. 1 Cleveland, home 225s., export 245s.; Silicious iron, home 225s., export 245s.: No. 3 Cleveland G.M.B., home 215s., export 235s.; No. 4 foundry, home 214s., export 229s.; No. 4 forge, home 212s. 6d., export 217s. 6d.; mottled, home 212s. 6d., export 217s. 6d.; white, home 210s., export 215s.; hematite East Coast mixed numbers, home 240s., export 245s.; No. 1, home 242s. 6d., export 247s. 6d. At Birmingham last week business in pig-iron was within very restricted limits, buyers evidently regarding the recent reductions in Midland prices as insufficient to stimulate demand, and consequently confining transactions to immediate requirements. With the exception of Lincolnshire iron, of which basic quality is offered at £8 10s., to meet Belgian competition, Midland prices remain stationary at the quotations submitted last week, the demand being confined mostly to foundry grades, and then only for limited quantities. Rumours have been current in Lancashire that foundry pig has been offered for local delivery at £11 per ton, but, of course, this is much below the current prices for Midland iron, and lower than the cost of Cleveland iron, which could not yet be delivered here under £11 12s. 6d. per ton. There is, however, more Cleveland iron now available for the Manchester market, and it is obvious that since this is the case, Midland ironfounders will not buy freely of the local irons at £11 15s. on trucks at the furnaces. In the Glasgow market the stoppage of works of late has had an adverse effect upon demand for Scotch pig-iron, and only limited sales for immediate needs are reported.

Scrap.

Business in the South Wales scrap market continues stagnant, with plenty of material offering at more or less nominal prices. Heavy scrap, £5 10s. to £6 10s.: bundled steel and shearings, £5 to £5 10s.; mixed iron and scrap for furnace use, £2 to £6; heavy cast-iron scrap for furnaces, £6 10s.; old machinery foundry scrap cast iron, £10 and over. Transactions in scrap material in Lancashire have almost reached the minimum point, but few definite price movements are recorded. Consumers' offers for heavy wrought scrap are now based upon about £6, while dealers continue to ask £10 per ton for best qualities of foundry metal, with few responses from buyers, which suggests anticipations of lower prices in the immediate future. There is now no market at Manchester for heavy steel melting scrap, quotations ruling nominally about £5 10s. per ton, with turnings of the same metal at greatly reduced prices. The market on Tees-side returns practically similar reports of the state of business, stocks accumulating in dealers' yards owing to the unsatisfactory conditions now experienced in that district in all branches of iron and steel consumption. It is hoped, however, that as the year advances prices all round may be stabilised, at lower levels for finished material, and this would undoubtedly react in favour of the scrap markets.

Steel.

The outlook in the steel trade at the moment can hardly be described as reassuring, and even the most optimistic observer may be excused for participating in the general air of depression now affecting most branches of the industry. The tendency everywhere is now inclined to an all-round lowering of values, for both finished and semi-steel products, makers' hands having been forced in this direction by the steadily growing encroachments of Continental competition. In this respect both English and Scotch makers have acted together, having decided last week to make a further reduction in their price lists. Small price cuts from time to time having been ineffectual as a stimulus to demand, the Scotch makers have accordingly reduced boiler plates to the extent of £1 per ton, ship plates (⅜-in. and up) £2, and sections £3. The quotations, as revised, are now £29, £22 10s., and £21 for the respective materials. All the new bases are net prices and subject to existing extras and conditions. The reaction from the highest prices touched in the course of the trade boom last year amounts to £2 10s. in boiler plates, £4 10s. in ship plates (⅜-in. and up), and £5 10s. in sections. Several works in the Clyde-side district have not been reopened since the New Year holidays began, and many rolling mills at those in operation are idle. As a further stage to stability in prices, the announcement will be welcomed by consumers, but whether the concessions thus outlined will lead to a more active buying movement is by no means assured with any degree of confidence. In the Sheffield district, little, if any, improvement can be noted in conditions, the position, if anything, steadily going from bad to worse each week, many of the principal steel firms having already exhausted the orders in hand, with little immediate prospect of an early replenishment in the way of fresh specifications. Practically free from foreign competition, acid steel is only in quiet demand, and several furnaces are idle. Some of the open-hearth furnaces have, however, been relighted, and some activity may also be noted in the heavy branches of the trade. No further reduction in selling prices of Sheffield steel has been notified, with the exception of bright drawn bars, the current quotation for which has been put down to £35, or 10s. below the October figure. Cold rolled strip prices are also reduced, but no movement has yet been made in values of basic and acid billets for local consumption. The progress of the electric furnace during recent years has been a somewhat remarkable feature of the world's steel industry, the latest returns estimating the total number in operation at the close of last year as 961, of which 356 are in the United States, which heads the list among the various countries where such plant is installed. There was an increase of 10 per cent. in the United States on the year. There are altogether 90

furnaces of the Greaves-Etchells type, of which 23 are in America. Germany contains one electric furnace of 30 and another of 28 tons capacity. There is nothing larger than 10 tons in England.

Finished Iron.

Conditions in most departments of the finished iron manufacturing industry, so far from improving, are growing steadily more depressed, demands for this class of products for either home or overseas markets having of late declined almost to the vanishing point. The only exception to an almost general rule is confined to best quality of bars, which so far have been free from the competitive menace experienced by the lower grade qualities. But even in the more favoured section of the trade there is a lack of stability, and although makers of marked bars are comparatively well-placed with regard to orders in hand, some uneasiness is expressed as to the future, new business hardly realising expectations in extent of volume that might have been anticipated after the recent reduction in prices. In the case of crown quality and other inferior grade bars, the position, if not exactly hopeless, is disappointing in the extreme, many of the mills in the Midlands and other districts of the industry running either at very low capacity or closed down until a revival of demand develops. Although for a long time past members of the bar-makers' Associations have loyally adhered to the price adjustments periodically revised by these authorities, there now seems some disposition in certain localities to adopt a more independent attitude, with the result that suggestions of under-cutting are rumoured in various quarters. It is current market rumour that some members desire unrestrained action in fighting foreign competition, while, on the other hand, it is pointed out that any reduction they could make would be of no avail against Belgian rivalry when quoting as low as £16 for No. 3 quality nut and bolt material, the price of which is to-day in Staffordshire and Lancashire fixed at £26 10s., with puddled bars about £21 to £22. From this comparison of prices of the home-made and foreign material it is evident that a much more substantial reduction must be effected before the disparity can be removed, and as there is at present no prospect of a corresponding decline in the costs of raw material, and even fainter hopes of a more reasonable attitude on the wages question by the workers, the position is apparently more complicated than ever. In the West of Scotland bar-iron makers are practically without orders on their books. Most of them now have arrears practically cleared off, and the present position at the works in this district may be realised when small rounds and squares, ½-in. and under, can be procured within seven to ten days. Yorkshire crown bars are £2 down.

Ore.

In the present depressed condition of the iron trade, the position of foreign ore is naturally affected in a similar manner, and to all intents and purposes business in this particular class of raw material is absolutely idle. Consumers, as a rule, are so heavily stocked that not only have they no need to buy, but frequently decline to accept deliveries under contract. Meanwhile, though the price of best rubio ore remains steady at 48s. on a 17s. freight basis, the latter is steadily declining, and from Bilbao to Tyne Dock there has been a fixture as low as 11s. 6d., equal to 12s. or 12s. 6d. to the Tees, which would make the c.i.f. price of best rubio ore about 42s. per ton. As far as native ore is concerned, the privately-owned iron-mines in the North-West area are closed down, but in the Furness district the men have agreed temporarily to accept the ruling selling price of pig-iron in lieu of the higher rates prevailing in November and December. This may be the first step in a new basis of cheaper iron. The current quotation for native ore is 59s. to 70s. per ton net at mines. Spanish ores are being imported at 50s. per ton, delivered

Tinplates.

Market conditions in the tinplate trade at present hardly convey the idea of an early revival of activity, many of the mills continuing idle or with partially suspended operations, while both buyers and sellers are of one mind as far as new business is concerned. According to a well-informed authority, there are at the present time over 2,500,000 boxes of tinplates in stock at the various works in South Wales, representing a value in hard cash of nearly £5,000,000. These boxes have been produced at a cost of about 40s. per basis box. One large firm in Swansea district has 1,000,000 boxes stocked at its works, and should they sell them at 33s. per box—the average ruling price—they stand to lose nearly a third of a million of money. It is needless to add that, apart altogether from price, the existence of these huge stocks will satisfy any recurring demand for some time to come, without restarting the works. With a view to stabilising the position of the industry, a movement is in progress to form a central selling agency, and in furtherance of the project a meeting was recently held at Swansea, at which tinplate makers controlling some 400 mills were represented. It is, however, understood that the attitude of merchants is antagonistic to the scheme, while almost insuperable difficulties have suggested themselves to makers, whose interests are not always exactly identical, and in many instances are directly competitive. Meantime the market continues stagnant, though generally the basis price is maintained at round 33s. Odd parcels have been sold at a shilling under, but, in view of the high cost of production, according to makers' statements, works are asking for higher prices, even 38s. to 39s. per box being named in some cases. Ternes are fairly firm at 36s. basis for the heavy gauges and 37s. for lights, f.o.t., but wasters are weaker at 22s. f.o.t. for quarters. There have been a few inquiries for tinplates from abroad, particularly from Japan and Norway and Sweden, but, so far, no actual business is reported. Current quotations are:—Cokes, 20 x 14, 33s., 37s.; ditto, quarters, 36s., 38s.; cokes, 20 x 10, 49s., 51s.; ditto, 28 x 20, 66s., 74s; ternes, 28 x 20, 73s., 75s

Hematite.

The position in the East Coast hematite pig-iron trade points unmistakably to a weakening tone, the steady decline in the cost of ore, following the fall in freights, permitting a reduction in price of mixed numbers as duly noted in a previous report. This, however, has, so far, not been effective in stimulating buying. A further concession made with a view to restoring the export trade has been to abolish the export premium of 5s. per ton on hematite. It is now possible to buy East Coast hematite for export at the same price as for home consumption, and on that basis a little business is already going through. Depression in the iron trade in Barrow and district is very acute. At the Barrow ironworks a furnace has been damped down, and it is stated that several furnaces have ceased operations. At present no iron is held in store, and there is a distinct set against piling up stocks of metal at existing high prices. Barrow makers have met the call for lower values at intervals during the last two months, and last week-end a further cut was made. Mixed numbers of Bessemer iron are now being quoted at £12 15s. per ton, with special brands at £13 5s. to £14 15s. per ton, both f.o.t.

Metals.

Copper.—The opening market of the week disclosed a more active tendency, but with a slack demand on manufacturer's account developed further weakness in values. Prices were still on the down grade, and marked a decline in both prompt and forward positions. Refined descriptions were again easier, both electrolytic and wire bars closing lower. According to preliminary official estimates the whole of the stocks of raw and refined copper in the United States at the close of the past year amounted to about 390,000 tons, thus indicating a decrease of 13,000 tons as compared with a year ago. Closing prices:—Cash: Wednesday, £70 5s.; Thursday, £70; Friday, £69 5s.; Monday, £67 15s.; Tuesday, £67. Three Months: Wednesday, £70 2s. 6d.; Thursday, £70 2s. 6d.; Friday, £69 10s.; Monday, £68; Tuesday, £67 5s.

Tin.—Influenced by Eastern advices to the effect that the "pegged" price of Straits tin had been withdrawn, the week's markets opened with a further weakening of values, renewed liquidation causing a severe reaction, in which the forward position figured as the chief sufferer. Consumptive demand continues depressed and most dealings were strictly confined to professional operators. Some idea of the weakness of markets may be realised from the fact that at the moment standard tin shows a decline of £250 per ton from the extreme level reached in February last, while conditions are still as uncertain as ever. Cash: Wednesday, £181 10s.; Thursday, £187; Friday, £179 10s.; Monday, £191; Tuesday, £164. Three Months: Wednesday, £187; Thursday, £191; Friday, £184 10s.; Monday, £191; Tuesday, £169 15s.

Spelter.—The market for this metal continues quiet and featureless, both prompt and forward values marking lower levels, the first-named having been sold at £24 15s.; February, £25 5s.; March, £25 10s.; April, £26; showing a loss of 15s. to 10s. for these respective dates.

Lead.—The tone throughout was steady, with only a small business passing. February sold at £25 10s., March at £25 10s. and £25 15s., April at £26, and January at £24 15s., there being further buyers at these prices.

Trade Talk.

A NEW blast furnace at Stanton Ironworks, with a capacity of 400 tons of pig-iron per week, was lighted last week by Major-General J. E. B. Seely, Member for Ilkeston.

LEADING mineral owners in Scotland are formulating a scheme for working thinner coal seams in the Clyde basin of Lanarkshire. Boring starts shortly, and experts foreshadow a new mining era in Scotland.

THERE is a large amount of shipping idle in the Wear at Sunderland, 16 vessels, with a total tonnage of 31,000, being laid up owing to the depression in the shipping trade. The depression is the greatest experienced since 1912.

THE SECRETARY TO THE MINISTRY OF LABOUR announces that the Military Service (Civil Liabilities) Department of the Ministry of Labour has removed to Cornwall House, Stamford Street, S.E.1, to which address all future communications should be made.

THE DIRECTOR-GENERAL OF COMMERCIAL INTELLIGENCE, Calcutta, in a cable message, states:—"It is anticipated that further restrictions on the export of coal from India may be necessary as measures hitherto adopted proved inadequate to relieve pressure on rolling stock."

TAW SHIPYARDS, LIMITED, Barnstaple, despatched on the 19th its first steel vessel, the "Gowerian," for Swansea, from which port she is to be used for general cargo purposes. The "Gowerian" has a gross registered tonnage of 449, with a dead-weight cargo capacity of 550 tons.

A LICENCE under the Non-Ferrous Metal Industry Act has been granted by the Board of Trade to the Duke of Bedford, Bedford Office, Tavistock. The licence permits the carrying on of the business of "winning, extracting, smelting, dressing, refining," and wholesale dealing in non-ferrous metals and ores.

PALMERS SHIPBUILDING AND IRON COMPANY, LIMITED, Jarrow, state that, owing to acute trade depression, they may be obliged to close down whole or part of the iron and steel works' plant, and have given notice to all employés in blast furnaces and steel works departments that from February 1 they will only be engaged from day to day as required.

THE intimation that the St. Vincent Works, Bristol, of John Lysaght, Limited, are to be closed down entirely at the end of this month, applies only to the export trade. The present adverse Australian exchange makes it extremely difficult to carry on business, and it is understood that immediately the position is rectified the works will be reopened.

MR. W. G. GRIFFITHS, a prominent official of the Iron and Steel and Kindred Trades' Confederation, speaking at Jarrow, said that at a conference with North-East Coast representatives, held at Newcastle last week, a resolution was unanimously carried in favour of providing an unemployment fund for the trade, to which employers and men would contribute equally.

MESSRS. WILLIAM JACKS & COMPANY, in a special review of the iron and steel trades for 1920, state: "When the year opened the world hunger for iron and steel was still unsatisfied . . . . and, almost regardless of cost, the whole world was clamouring for supplies. To-day the position is completely reversed. It is an inexorable law that every advance in price must curtail the demand."

THE report of the Council of the Birmingham and Midland Institute presented at the recent annual meeting, states that the year which closed on November 30 last has been a year of marked progress in all departments of the Institute. There has been a striking increase in the numbers of members and students, an increase which is causing the Council considerable anxiety owing to the pressure on the accommodation available.

WE have recently received from the Monometer Manufacturing Company (1918), Limited, Savoy House, 115, Strand, London, W.C.2, particulars of a new type of case-hardening furnace now being made in large quantities, and particularly suitable for garages, tool-rooms, and case-hardeners, as it will work without air blast, and need only be connected up to a ¾-in. town gas main.

SOUTH WALES copper workers have agreed to five per cent. reduction in wages. It was stated that unless the men accepted the works would close down.

THE BOARD OF TRADE has, under the Gas Regulation Act, 1920, fixed the rate of contribution to the gas fund for the year 1921 at 3s. for each million cubic feet of gas sold during 1920. From this fund are paid the salaries, etc., of the gas examiner, gas referees, and their assistants appointed under the Act for the testing of gas.

Messrs. John Macdonald & Company, pneumatic engineers, Pollokshaws, Glasgow, exhibited at the recent Shipbuilding, Engineering and Electrical Exhibition at Kelvin Hall, Glasgow, a "Berkshire" moulding machine. This is a stationary standard model, completely equipped with air cylinder for power-squeeze, with cope roll-over and two vibrators. This machine is suitable for plate pattern, split pattern, or stripping plate work. It takes a flask up to 16 in. by 24 in., and has a lift of 7½ in. which can be divided between cope and drag to suit. The squeeze can be operated either by hand or by air, and can be adjusted to make the drag or the cope of any desired hardness—a feature not found in other machines of this class—while the lift employed is claimed also by the makers to be the most perfect devised.

MR. MAURICE S. GIBB, C.B.E., managing director of Messrs. Wm. Gray & Company, West Hartlepool, presided at a recent meeting of the Tees and Hartlepools district of the Foremen's Society, when a paper on "Steel" was read by Mr. J. W. Patterson, metallurgical chemist. Some discussion took place regarding the work of the classification societies and their rules, particularly in the matter of the manufacture of boiler plates.

THE directors of Vickers, Limited, have issued a statement of their war work for the four years to December 31 last. Extensions were made at all the company's works, a total increase of 370 acres, bringing the total area of the company's works to nearly 770 acres. The firm manufactured over 21,600,000 shot and shell, the bulk of which were finished before the Armistice. In one shop at Barrow women workers produced over 45,000 finished 3-in. shells per week. Three large and six smaller airships of the rigid type were constructed during the war. The total number of aeroplanes manufactured by Vickers during the war was 5,500. Drop forgings, particularly for the 6-throw crankshafts for airship and aeroplane engines, were produced by the Sheffield works at the rate of 500 per week.

"L'ASSOCIATION BELGE DE STANDARDISATION" has published its first report comprising rules for the construction and standardisation of: (1) Metal frameworks; (2) metal reservoirs; (3) walls and roofs of galvanised corrugated iron; (4) transmission shafting and pulleys; (5) metal bridges; (6) bolts and rivets. The Association have now under consideration the establishment of principles for the measurement and construction of buildings in reinforced concrete, and for the standardisation of apparatus for the distribution of water. They are also studying questions affecting the mining and electrical industries.

THE BOARD OF TRADE have appointed Sir R. T. Glazebrook, K.C.B., F.R.S., to be Chief Gas Examiner under that Act, and Mr. C. V. Boys, F.R.S., Mr. J. S. Haldane, F.R.S., and Mr. W. J. Atkinson Butterfield, M.A., F.I.C., F.C.S., to be Gas Referees. The Board have also appointed Mr. H. C. Honey to be Director of Gas Administration in the Power Transport and Economic Department. Sir William Pearce, M.P. (chairman), Dr. T. Carnwath, D.S.O., M.B., Mr. William Doig Gibb, O.B.E., M.Inst.C.E., and Dr. T. Gray, D.Sc., Ph.D., have been nominated as a committee to inquire whether it is necessary or desirable to prescribe any limitation of the proportion of carbon-monoxide which may be supplied in gas used for domestic purposes, and also Mr. James Hunter Gray, K.C. (chairman), Mr. W. J. Atkinson Butterfield, M.A., F.I.C., F.C.S., and Dr. C. H. Lander, D.Sc., M.I.M.E., A.M.I.C.E., to inquire whether it is necessary or desirable to prescribe any limitations of the proportions of incombustible constituents which may be supplied in gas.

Legal.

Judgment was recently delivered by one of the Official Referees in an action in the King's Bench Division, in which Keeling & Walker, Limited, of Stoke-on-Trent, sought £8,525 19s. 4d. damages for alleged breach of contract in connection with an installation of a dust recovery and cooling plant used in the manufacture of zinc oxide. The effect of the evidence was to show that the recovery plant in question was of the suction filter type, claimed to have advantages over the ordinary type of pressure filter used in recovering zinc oxide in the course of manufacture; that, when set to work, certain modifications were found to be necessary; but that before they could be effected Keeling & Walker, Limited, on their own motion altered the design of the furnace and the arrangement of hoods and connecting pipes.

After hearing Keeling & Walker's case, and without calling on the contractors, the Official Referee delivered judgment for the contractors (Sturtevant Engineering Company, Limited) with costs, holding that there had been no breach of contract and that the claim failed.

The counsel for the plaintiffs were Mr. Maddocks, K.C., M.P., and Mr. Sturge, and for the defendants, Sir Malcolm Macnaughten and Mr. Theo. Mathew.

THE LATE MR. ROBERT JOHN O'BRIEN, of Brooklands, Cheshire, electrical engineer, left £5,525.

Personal News.

THE late Mr Thomas Black, of Cullercoats, iron and steel merchant, left £9,925.

SIR JOHN CHARLES LEWIS COWARD, K.C., has been appointed a Railway and Canal Commissioner in the place of Lord Terrington, resigned.

THE LATE MR GEORGE HAYTON, retired managing director of Messrs. J. and J. Ingham & Company, Limited, nail works, left net personalty £19,127.

MR. CHARLES FREDERICK MARRINER, of 38, Woodberry Down, N., and Thorpe Hall, Hasketon, Suffolk, head of Crosby, Marriner & Company, Limited, bedstead manufacturers, Birmingham, left £28,759.

THE late Mr. Franklin Hilton, M.I.C.E., M.I.M.E., 27, Duke Street, Southport, chairman of Browett, Lindley & Company, Limited, and a director of J. Grayson, Lowood & Company, Limited, left £33,392.

MR. JOHN STUBBS, of Faircroft, Solihull, managing-director of the Hughes Stubbs Metal Company, and director of Cooper & Goode and Elliott's Metal Company, left gross estate of the value of £36,760, with net personalty £29,151.

THE late Mr. Ralph Richardson, of Worsborough Hall, near Barnsley, mining engineer, agent for the collieries of the Barrow Hematite Steel Company, Limited, and chairman of the South Yorkshire Coalowners' Association, left personal estate valued at £34,516.

MR. GEORGE TANGYE, of Birmingham, chairman of Tangye, Limited, who died October 7, aged 65 years, left £207,137 gross and £172,320 net. He was one of the three brothers who left a tiny blacksmith's shop in Cornwall and founded in Birmingham the world-famous engineering works.

Deaths.

THE death occurred at North Shields, recently, of Mr. Tom Baird, engineer, aged 45, one of the managing directors of the firm of Messrs. Baird Brothers, Limited, dry-dock owners, engineers, and ship repairers, of North Shields.

THE death occurred at Frondeg, Neath, on the 15th inst., of Mr. D. M. Jenkins, the borough engineer of Neath. Mr. Jenkins, who was 58 years of age, was appointed borough engineer in succession to the late Mr. William Whittington in 1886.

THE death is reported of Mr. Thompson Siddell, of Elmfield, Blackhill, in his 78th year, whose father was manager of the Consett Iron Company's tinmill works. Prior to his retirement in 1914 he had been in the service of the Consett Iron Company for over 60 years.

Applications for Patents.

Evans & Company, J., and McClelland, J. J. Foundry moulding box. 33,306. November 25.

Ferranti, Limited. Cast-iron alloy. 33,290. November 25.

Haddon, H. Couplings for colliery trams, etc. 33,118. November 24.

Leigh, A. P. Foundry moulding-boxes. 33,247. December 25

South Metropolitan Gas Company. Determining calorific value of coal gas, etc. 33,037. November 23.

Andrews, E. P. Process for rust-proofing metal. 34,102. December 2.

Baker, Sons & Perkins, J., and Kirman, H. Conveyor chains. 33,986. December 1.

Ballantine, W. B., and Stig, G. and E. Refining ferro-alloys. 34,005. December 1.

Ballantine, W. B., and Stig, G. and E. Production of ferro-alloys. 34,006. December 1.

Cowing, P. F. Manufacture of nickel steel. 34,140. December 2. (United States, June 16.)

Mainwaring, D. Furnace doors. 33,685. November 29.

Raffo, M. Manufacture of iron and steel. 34,125. December 2.

Ges. für Wolfram-Industrie. Metal alloy for wire-drawing dies, etc. 34,575. December 7. (Germany, January 23, 1918.)

Wellman Smith Owen Engineering Corporation, and Thompson, F. W. Apparatus for manipulating ingots and their moulds, and for stripping ingots of their moulds. 34,583. December 7

We have received from Messrs. N. Taylor & Son, 17, Goree Piazzas, Liverpool, a descriptive booklet dealing with "Hydro-carbonated Bone Black for Case-hardening."

Company News.

William Perch, Limited.—Private company. Capital £50,000 in £1 shares. To carry on the business of colliery owners, coal, coke, fuel, timber, pitwood, and general merchants, etc. The first directors are: W. M. Lewis (chairman), W. H. Lewis, and A. M. Thomas, Radyr.

Ystalyfera Collieries, Limited.—Private company. Capital £60,000 in £1 shares. The objects are:—To adopt an agreement with D. Davies, and to carry on the business of colliery owners and coal exporters, etc. Registered office: Victoria Buildings, Victoria Road, Swansea.

R. W. Crabtree & Company, Limited.—The directors announce that, having regard to financial situation, they have decided to postpone payment of half-yearly dividend on 8 per cent. cumulative participating preference shares due December 31, 1920, in order to conserve resources.

Welding Specialists Company, Limited. — Capital £3,000 in £1 shares. To acquire the welding business established by V. J. Spiganovicz and H. Batt, 172, Easter Road, Edinburgh, known as the Welding Specialists Company. Registered office: 15, Stafford Street, Edinburgh.

Elliotts' Metal, Limited.—The following interim dividends have been declared, less tax: 5 per cent. per annum on preference for six months, 7s. per share on ordinary. Similar dividends will be paid in respect of new shares, which are to be issued in exchange for shares in Muntz's Metal Company.

The Sheffield Union Grinding Wheel, Limited.—The report of the directors for 1920 shows a loss of £320 on the year's trading. Further, it is said that the "Wheel" cannot be run at a profit under existing conditions. The directors, therefore, now propose to confer with the shareholders as to the future of the undertaking.

Baldwins, Limited.—The trading profits for the year ended June 30 last, after providing for excess profits and corporation profits taxes, and writing off special depreciation on war values, amounted to £683,405. A dividend of 12½ per cent., free of income-tax, is proposed on the ordinary shares, adding to the depreciation fund £75,000 and to reserve £75,000, and carrying forward £291,324.

Gwynnes, Limited.—Report for period of four years and eight months ended September 30, 1920, states that dividends have been paid during period on preference and ordinary up to January 31, 1920, amounting in all to £25,000. Balance to credit of profit and loss, £50,313. Dividend for eight months to September 30, 1920, at rate of 5 per cent. on preference and 10 per cent. on ordinary, less tax, leaving £46,980 to be carried forward.

Broadoak Collieries, Limited.—Capital £175,000 in £1 shares. To acquire certain freehold and leasehold mineral interests in Longher, Glam., and carry on the business of miners, smelters, colliery proprietors, coke manufacturers, iron masters and founders, etc. The permanent directors are:—L. D. Howell, M. J. Thomas, E. Lewis, W. J. Stephens, J. Hargreaves, D. I. Evans, and G. Stephens. Secretary: R. Gwilym. Registered office: Atlantic Buildings, Swansea.

John Walters & Company, Limited.—Private company. Capital £10,000 in £1 shares. To carry on the business of colliery agents and coal exporters, pitwood and timber merchants, shipowners, etc. Secretary: J. Walters, Port Talbot.

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BOILER, SHIP and BRIDGE PLATES, etc. ANGLES and all forms of Sectional Bars. TYRES and AXLES to all requirements. CASTINGS of all kinds and of Largest Sizes. FORGINGS of every description. BILLETS, BLOOMS, RAILS.

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Machinery for Making Tubes and Wire.

MILL GEARING OF EVERY DESCRIPTION.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	67	0	0
Three months	67	5	0
Electrolytic	78	10	0
Tough	75	10	0
Best selected	75	10	0
Sheets	127	0	0
India	127	0	0
Wire bars	78	10	0
Do. Feb.	78	10	0
Do. Mar.	78	10	0
Ingot bars	77	10	0
H.C. wire rods	87	10	0
Off. aver. cash, Dec.	75	16	8
Do. 3 mths., Dec.	76	3	4
Do. Settlement Dec.	75	15	2⅝
Do. Electro. Dec.	86	13	6⅝
Do. B.S., Dec.	84	13	4
Aver. spot, copper, Dec.	75	14	10½
Do. Electro, Dec.	88	0	5¾

S.D. tubes 17½d.
Brazed tubes 17½d.
Wire 15d.
Y.M. rods 9½d.
Do. 4x4 Sqs. 14d.
Do. 4x3 Sheets 14d.

BRASS.

S.D. tubes 15d.
Brazed tubes 18d
Rods 13⅝d.
Sheets to 10 w.g. 13½d.
Wire 13½d.
Rolled metal 12¾d.

TIN.

Standard cash	171	10	0
3 Months	177	5	0
English	166	10	0
Bars	168	10	0
Chinese	165	10	0
Straits	196	10	0
Australian	178	0	0
Eastern	236	0	0
Banca	196	10	0
Off. aver., cash, Dec.	212	11	8
Do. 3 mths., Dec.	216	17	1½
Do. Sttlment., Dec.	212	10	5½
Aver. spot, Dec.	212	7	10½

SPELTER.

Ordinary	24	15	0
Remelted	19	0	0
Hard	17	10	0
Electro 99.9	34	10	0
English	27	0	0
India	21	0	0
Prime Western	26	0	0
Zinc dust	60	0	0
Zinc ashes	6	10	0
Off. aver., Dec.	28	11	6½
Aver., spot, Dec.	26	9	0

LEAD.

Soft foreign ppt	23	0	0
English	25	0	0
Off. aver., Dec.	24	11	10½
Aver. spot, Dec.	17	19	0

ZINC SHEETS.

Zinc sheets, spot	40	10	0
Do. V.M. ex. whf.	40	0	0
Do. ppt., f.o.b., N.Y.			—
Do. c.i.f.			—
Boiler plates	38	10	0
Battery plates	39	10	0

ANTIMONY.

Eng. regulus	40	0	0
Special brands	42	0	0
Chinese	25	0	0
Crude	23	0	0

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Quicksilver 12 12 6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
45/50% £19 0 0
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Ferro-vanadium—
35/40% 32/- lb. va.
Ferro-molybdenum—
70/80% 7/9 lb. mo.
Ferro-titanium—
23/25%, carbonless 1/6 lb.
Ferro-phosphorus, 20/23%, £49
Ferro-tungsten—
80/85%, carbon low 2/5 lb.
Tungsten metal powder—
98/99% 3/3 lb.
Ferro-chrome—
4/6% car. £37 10
6/8% car. £37
8/10% car. £36 10
Ferro-chrome—
Max. 2% car. £88
Max. 1% car. £106
Max. 0.75% car. £123
65/75%, carbonless 3/- lb.
Nickel—99·8%, cubes or pellets £215
Cobalt metal—97%.. 20/- lb.
Aluminium—98/99% £165
Metallic Chromium—
98/99% 7/6 lb.
Ferro-manganese—
76/80%, loose £32
76/80%, packed £33
76/80%, export £33
Metallic manganese—
98/99%, carbonless 3/6 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten s. 3 d. 2
Finished bars, 18% tungsten 4 0
Scrap pieces 5d.
Turnings and swarf 3d.
Per lb. net, d/d works.

SCRAP.

South Wales—	£	s.	d.	£	s.	d.
Heavy Steel	5	10	0	6	10	0
Bundled steel & shearings	5	0	0	5	10	0
Mixed iron & steel	2	0	0	6	0	0
Heavy cast iron				6	10	0
Good machinery for foundries				10	0	0
Cleveland—						
Heavy steel				7	0	0
Steel turnings				6	5	0
Steel borings				6	5	0
Heavy wrought iron piling				8	5	0
Bundling scrap				7	15	0
Cast-iron scrap				10	5	0
Lancashire—						
Cast iron scrap				10	0	0
Heavy wrought				6	0	0
Steel turnings				6	0	0
London—						
Copper (clean)				58	0	0
Brass (clean)				37	0	0
Lead (less usual draft)				18	0	0
Tea lead				16	0	0
Zinc				13	0	0
New aluminium cuttings				105	0	0
Braziery copper				48	0	0
Gun metal				56	0	0
Hollow pewter				135	0	0
Shaped black pewter				85	0	0

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Foundry No. 1 225/-
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FINISHED IRON & STEEL.

Iron—	£	s.	£	s.	d.
Bars (cro'n)	24	0	26	10	0
Angles	24	10	27	0	0
Tees to 3 united ins.	25	0	27	10	0
Nut and bolt			26	10	0
Hoops			26	5	0
Marked bars (Staffs.)			33	10	0
Gas strip			32	10	0
Bolts and nuts, ¾ in. × 4 in.			51	0	0
Steel—					
Ship plates			22	10	0
Boiler plates			29	10	0
Checquer plates			28	0	0
Angles			21	0	0
Tees			22	0	0
Channels			22	15	0
Joists			21	0	0
Rounds, ⅜ in.–3-in.			22	0	0
Rounds, 3 in.–5½ in.			21	0	0
Flats, 5 in.–8 in.			21	10	0
Flats over 8 in.			21	0	0
Rails, heavy			22	0	0
Fishplates			27	0	0
Hoops			23	5	0
Black sheets, 24 g.			26	10	0
Galv. cor. sheets, 24 g.			28	0	0
Galv. fencing wire, 8 g. plain			38	10	0
Rivets, ¾ in. dia			39	0	0
Billets, soft			15	0	0
Billets, hard			16	0	0
Sheet and tin bars			17	0	0

PHOSPHOR BRONZE.

Rolled.	Per lb. s.	d.
½ in. to 1 in. wide	2	1½
1 in. to 1½ in. wide	2	0½
1½ in. to 2 in. wide	1	11¼

Strips.	s.	d.
2 in. to 6 in. to 26 S.W.G.	1	10½
6 in. to 12 in. to 26 S.W.G.	1	10¼

Sheets.	s.	d.
12 in. to 18 in. to 24 S.W.G.	1	11
18 in. to 24 in. to 24 S.W.G.	1	11¾
24 in. to 30 in. to 20 S.W.G.	2	0¾
30 in. to 36 in. to 16 S.W.G.	2	1¼
36 in. to 42 in. to 16 S.W.G.	2	2¼

Extras.

For Gauge: Any width up to 36 in. wide, ¼d. per lb. per thinner gauge.

Drawn Rods.	s.	d.
¼ in. to ⅝ in. dia. in random lengths	1	11½
⅝ in. to 1½ in. dia. in random lengths		
Over 1½ in. to 1¾ in.	1	11½

Tubes—basis price 2 1½
Delivery 2 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
Charles Clifford & Son, Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	1/3 to 1/9
Rolled—	
To 9 in. wide	1/10½ to 2/4½
To 12 in. wide	1/11 to 2/5
To 15 in. wide	2/- to 2/6
To 18 in. wide	2/1 to 2/7
To 21 in. wide	2/2 to 2/8
To 24 in. wide	2/3 to 2/9
Ingots for spoons and forks	1/3 to 1/9
Ingots rolled to spoon size	1/6 to 2/-
Wire round—	
3/0 to 10. G.	2/1 to 2/8

with extras according to gauge.

SWEDISH IRON.

F.O.B. Gothenburg net cash.

	Basis price. £	s.	d.
Bars, hammered basis sizes	33	0	0
Rolled Ordinary—Assortment	to		
Nail Rods—Square, round and flats	40	0	0
Keg Steel } about Faggot Steel } £50	Prices nominal.		
Blooms—			
Single welded	£20 to £25		
Billets—			
Single and double welded	£22 to £27		
Pig-Iron—			
Grey, white or mottled	£15 to £20		

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	33.79
No. 2 foundry Valley	33.00
No. 2 foundry, Birm.	36.00
Basic	31.96
Bessemer	33.96
Malleable	35.96
Grey forge	34.96
Ferro-manganese, Atl. port	110.00
Bess. rails, h'y, at mill	45.00
O.-h. rails, h'y, at mill	47.00
Bess. billets	43.50
O.-h. billets	43.50
O.-h. sheet bars	47.00
Wire rods	57.00

	Cents.
Iron bars	3.50
Steel bars	2.35
Tank plates	2.65
Beams, etc.	2.45
Skelp, grooved steel	2.65
Skelp, sheared steel	2.65
Steel hoops	3.05
Sheets, black, No. 28	4.35
Sheets, galv., No. 28	5.70
Sheets, blue an'l'd, 9&10	3.55
Wire nails	3.25
Plain wire	3.25
Barbed wire, galv.	4.10
Tinplate, 100-lb. box	$7.00

COKE.

Welsh foundry 72/6
„ furnace 55/-
Durham & North foundry 70/-
„ furnace 62/9
Other Districts, foundry 77/9
„ furnace 55/-